

# NUCLEAR SCIENCE ABSTRACTS

Vol. 8, No. 10, May 31, 1954

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## ERRATA

NSA, Vol. 8, No. 1, p.10. In abstract 79, California Univ., Davis should be California Univ., Davis. Coll. of Agriculture.

NSA, Vol. 8, No. 1, p.21. In abstract 189, AERE-1/M-28 should be AERE-1/M-28.

NSA, Vol. 8, No. 1, p.36. In abstract 320, NP-4486 should be NP-4486; WAL-401/87-11.

NSA, Vol. 8, No. 3, p.114. In abstract 966, AERE-1/M-29 should be AERE-1/M-29.

## NOTICE

It has been necessary to omit the author index usually included in this issue. A cumulated author index for Vol. 8, Nos. 1-12A will appear in No. 12B, dated June 30, 1954.





## SELECTED SUBJECTS OF INTEREST TO INDUSTRY

All AEC reports abstracted in this issue of Nuclear Science Abstracts have been reviewed and evaluated in terms of their interest and usefulness to general industry. These reports are listed below by title, author, and report number under one or more of the following nine broad categories: Chemistry and Chemical Engineering; Construction and Civil Engineering; Electronics and Electrical Engineering; Health and Safety; Industrial Management; Mechanics and Mechanical Engineering; Metallurgy and Ceramics; Mining and Geology; and Nuclear Technology. The abstract number for each report is listed at the upper right of the entry and refers to an item in the current issue of NSA.

All unclassified reports considered to be of special interest to general industry issued by the AEC prior to July, 1953 are listed or abstracted in a series of bibliographies (TID-3050), the titles of which correspond to the above-mentioned categories. As these background bibliographies become available for sale, the prices will appear in the Numerical Index of Reports which is included in each issue of this volume of NSA. These bibliographies may be purchased from the U. S. Department of Commerce, Office of Technical Services, Washington 25, D. C.

Reproduction in whole or part of any report listed herein is encouraged by the United States Atomic Energy Commission, subject to the approval of authors or originating sites. General inquiries from the industrial press about AEC-developed information may be directed to the Industrial Information Branch, AEC, Washington 25, D. C.

### CHEMISTRY AND CHEMICAL ENGINEERING

- |   |      |
|---|------|
| ISC-293<br>Ames Lab.<br>MASS SPECTROMETRIC DETERMINATION OF LATENT HEATS OF METALS. Robert G. Johnson, D. E. Hudson, and F. H. Spedding. Dec. 1952. 107p. Contract W-7405-eng-82. (ISC-293)   | 2848 |
| ISC-431<br>Ames Lab.<br>A COINCIDENCE SCINTILLATION SPECTROMETER. Sven A. E. Johansson. Dec. 9, 1953. 21p. Contract W-7405-eng-82. (ISC-431)  | 2940 |
| ISC-456<br>Ames Lab.<br>SPECTROPHOTOMETRIC DETERMINATION OF THORIUM WITH THE TRISODIUM SALT OF 2-(2-HYDROXY-3,6-DISULFO-1-NAPHTHYLAZO)-BENZENEARSONIC ACID AND SOME PROPERTIES OF COMPLEXES INVOLVED. Carol H. Byrd and Charles V. Banks. June 1953. 96p. [Contract W-7405-eng-82]. (ISC-456) | 2772 |
| ORNL-1373<br>Oak Ridge National Lab.<br>RADIATION STABILITY OF PLASTICS AND ELASTOMERS (SUPPLEMENT TO ORNL-928). C. D. Bopp and O. Sisman. July 23, 1953. 87p. Contract W-7405-eng-26. (ORNL-1373)  | 2792 |
| ORNL-1688<br>Oak Ridge National Lab.<br>SODIUM PLUMBING. A REVIEW OF THE UNCLASSIFIED RESEARCH AND TECHNOLOGY INVOLVING SODIUM AT THE OAK RIDGE NATIONAL LABORATORY. William B. Cottrell and Leland A. Mann. Aug. 14, 1953. 82p. Contract W-7405-eng-26. (ORNL-1688)                          | 2824 |

### ELECTRONICS AND ELECTRICAL ENGINEERING

- |   |      |
|---|------|
| HW-30712<br>Hanford Works<br>AN ELECTRONIC HIGH VOLTAGE SUPPLY. W. G. Spear. Feb. 1, 1954. 12p. Contract W-31-109-Eng-52. (HW-30712)  | 2925 |
| K-1109<br>Carbide and Carbon Chemicals Co. (K-25)<br>TEMPERATURE REGULATOR FOR A RESEARCH FURNACE OPERATING BETWEEN 500° AND 600°C. J. H. Lykins and H. S. McKown. Mar. 12, 1954. 12p. Contract W-7405-eng-26. (K-1109) | 2926 |
| LRL-103<br>Livermore Research Lab., Calif. Research and Development Co.<br>HIGH SPEED COUNTING USING THE E1T DECADE COUNTER TUBE. R. E. Nather. Mar. 1954. 18p. Contract AT(11-1)-74. (LRL-103)                         | 2941 |
| MLM-911<br>Mound Lab.<br>A DIRECT-CURRENT CONSTANT-POWER POWER SUPPLY. (INFORMATION REPORT). T. L. Zinn, J. W. Heyd, W. L. Hood, and J. A. Williamson. Sept. 5, 1953. 11p. Contract AT-33-1-GEN-53. (MLM-911)           | 2927 |
| NYO-4576<br>Health and Safety Lab., New York Operations Office, AEC<br>EFFECT OF AGE ON THE REPRODUCIBILITY OF FILM BADGE DENSITY READINGS. Keran O'Brien and Leonard Solon. Feb. 1954. 5p. (NYO-4576)                  | 2942 |
| NYO-4578<br>Health and Safety Lab., New York Operations Office, AEC<br>"DEEDLEBUG"—A GAMMA RAY DRILL HOLE LOGGING PROBE UNIT. H. D. LeVine and Ole Pedersen. Feb. 25, 1954. 5p. (NYO-4578)                              | 2943 |



ORNL-1669 2944  
Oak Ridge National Lab.  
THE CHARACTERISTICS OF AN ELECTRON MULTIPLIER  
AS A DETECTOR OF HEAVY PARTICLES. Clarence F.  
Barnett. Feb. 15, 1954. 84p. Contract W-7405-eng-26.  
(ORNL-1669)

UCRL-2049(Rev.) 2931  
Radiation Lab., Univ. of Calif., Berkeley  
EXTENDING THE RANGE OF A SELF-BALANCING RE-  
CORDING POTENTIOMETER WITHOUT REDUCING RESO-  
LUTION. H. B. Keller and C. G. Dols. Jan. 11, 1954. 14p  
Contract W-7405-eng-48. (UCRL-2049(Rev.))

UCRL-2495 2945  
Radiation Lab., Univ. of Calif., Berkeley  
A LINEAR, TRANSPARENT BEAM INTEGRATOR. Sumner  
W. Kitchen. Feb. 12, 1954. 7p. Contract W-7405-eng-48.  
(UCRL-2495)

## HEALTH AND SAFETY

LA-1629 2738  
Los Alamos Scientific Lab.  
BIOLOGICAL EFFECTIVENESS OF 14 MEV NEUTRONS!  
SPLEEN AND THYMUS WEIGHT LOSS IN MICE AS THE  
BIOLOGICAL INDICATOR. Payne S. Harris, L. Edward  
Ellinwood, E. C. Anderson, Rowland W. Davis, William  
Schweitzer, and Phyllis Sanders. Dec. 1953. 16p. Con-  
tract W-7405-eng-36. (LA-1629)

NYO-4577 2840  
Health and Safety Lab., New York Operations Office, AEC  
MATHEMATICAL EVALUATION OF AIRBORNE RADIO-  
LOGICAL SURVEY DATA. Ole Pedersen. Feb. 23, 1954.  
9p. (NYO-4577)

## MECHANICS AND MECHANICAL ENGINEERING

KAPL-926 2823  
Polytechnic Inst. of Brooklyn  
DEFORMATIONS AND STRESSES IN CIRCULAR CYLIN-  
DRICAL SHELLS CAUSED BY PIPE ATTACHMENT.  
PART 6. DERIVATION OF GENERALIZED DONNELL-  
TYPE EQUATIONS FOR CIRCULAR CYLINDRICAL  
SHELLS WITH APPLICATION TO SHELLS WITH LINE  
LOADS ALONG GENERATRICES. Joseph Kempner. June  
1953. 37p. Contract W-31-109-eng-52, Subcontract K-130  
to Knolls Atomic Power Lab. (KAPL-926)

## METALLURGY AND CERAMICS

AECD-3610 2846  
Ames Lab.  
CONSTITUTION DIAGRAM OF THE ANTIMONY-

ZIRCONIUM ALLOY SYSTEM. R. F. Russi, Jr. and H. A.  
Wilhelm. Aug. 1951. Decl. with deletions Jan. 18, 1954.  
42p. Contract W-7405-eng-82. (AECD-3610; ISC-204)

AECU-2827 2847  
Minerals Research Lab., Inst. of Engineering Research,  
Univ. of Calif., Berkeley  
INFLUENCE OF SUBSTRUCTURE ON THE SHAPE OF THE  
CREEP CURVE. T. H. Hazlett, R. D. Hansen, and E. R.  
Parker. Mar. 1954. 23p. Contract AT-11-1-Gen-10,  
Technical Report No. 13. (AECU-2827)

ISC-460 2849  
Ames Lab.  
ELECTROSTATIC ENERGY CALCULATIONS FOR SODIUM  
TUNGSTEN BRONZE ( $\text{Na}_2\text{WO}_3$ ). J. F. Smith. Feb. 15,  
1954. 21p. Contract W-7405-eng-82. (ISC-460)

KAPL-1066 3095  
Knolls Atomic Power Lab.  
THE EFFECT OF SHORT TIME MODERATE FLUX NEU-  
TRON IRRADIATIONS ON THE MECHANICAL PROPERTIES  
OF SOME METALS. F. W. Kunz and A. N. Holden. Feb. 19,  
1954. 45p. Contract W-31-109-eng-52. (KAPL-1066)

NAA-SR-261 3096  
North American Aviation, Inc.  
ELECTRON MICROSCOPE STUDY OF SLIP BANDS IN  
RADIATION DAMAGED ALUMINUM CRYSTALS. E. M.  
Kelly. Mar. 15, 1954. 15p. Contract AT-11-1-gen-8.  
(NAA-SR-261)

NYO-6292 2830  
Massachusetts Inst. of Tech.  
STUDY OF METAL-CERAMIC INTERACTIONS AT  
ELEVATED TEMPERATURES. QUARTERLY PROGRESS  
REPORT FOR THE PERIOD ENDING JANUARY 1, 1954.  
F. H. Norton, W. D. Kingery, et al. Jan. 1, 1954. 6p.  
Contract AT(30-1)-1192. (NYO-6292)

## NUCLEAR TECHNOLOGY

LRL-97 2878  
Livermore Research Lab., Calif. Research and Develop-  
ment Co.  
DIFFUSION EQUATION FOR RADIOACTIVE SPECIES IN  
THIN-PLATE NUCLEAR REACTORS. L. M. Litz. Mar.  
1954. 13p. Contract AT(11-1)-74. (LRL-97)

ORNL-1537 3032  
Oak Ridge National Lab.  
DETERMINATION OF THE POWER OF THE BULK  
SHIELDING REACTOR. PART 3. MEASUREMENT OF THE  
ENERGY RELEASED PER FISSION. J. L. Meem, L. B.  
Holland, and G. M. McCammon. Mar. 11, 1954. 88p.  
Contract W-7405-eng-26. (ORNL-1537)



An asterisk preceding the abstract number indicates that the corresponding report is included in the "Selected Subjects of Interest to Industry" section of this issue.

## GENERAL

2733

Commissariat à l'Énergie Atomique (France)  
ELABORATION D'UNE CLASSIFICATION ALPHA-NUMERIQUE POUR LE FICHIER MATIERES DU SERVICE DE DOCUMENTATION DU COMMISSARIAT A L'ENERGIE ATOMIQUE. [Elaboration of an Alpha-Numeric Classification for the Subject Catalog of the Documentation Service for the French Atomic Energy Commission]. P. Braffort. Dec. 1953. 70p. (CEA-238)

2734

AN OSCILLOGRAPHIC METHOD FOR DETERMINING VELOCITIES OF DETONATION IN EXPLOSIVES. Frank C. Gibson (Bureau of Mines, Bruceton, Penna.). *Rev. Sci. Instr.* 25, 226-31(1954) Mar.

The method and apparatus are described for determining velocities of detonation over one to five adjacent segments of an explosive charge. Time intervals are determined to the nearest 0.1 microsecond, which permits an accuracy of the order of 1 percent where distances of 10 centimeters are employed in 7000 m/sec explosives. Representative data are included to show the accuracy of the method as well as application techniques. (auth)

## BIOLOGY AND MEDICINE

2735

Tennessee Univ.  
AGRICULTURAL RESEARCH PROGRAM. SEMI-ANNUAL PROGRESS REPORT FOR JULY 1 TO DECEMBER 31, 1953. Apr. 1954. 114p. Contract AT-40-1-GEN-242. (ORO-110)

Data are presented which indicate that  $\text{Sr}^{90}$  and  $\text{Ca}^{45}$  were exchanged into bone and absorbed from the digestive tract to the same degree. However, ingested  $\text{Ca}^{45}$  was preferentially secreted into the milk of dairy cows by a factor of 6 to 10 over  $\text{Sr}^{90}$ . Also, dietary Ca was preferentially utilized for new bone formation in rats by a factor of 3 over  $\text{Sr}^{90}$ . Fecal excretion of  $\text{Ca}^{45}$  varied from 3% of the ingested dose in 10-day-old calves to 83% in aged cattle. The daily fecal endogenous Ca was in the range of 14 to 21 mg/kg of body weight for 30-day-old to aged cattle. The use of these methods is described for estimation of the maintenance requirement and true availability of Ca in various feeds. From  $\text{Ca}^{45}$  distribution results, it was estimated that in 6-month-old cattle, the percent of exchangeable bone Ca was somewhere between 9 and 60 whereas in aged cattle the value fell somewhere between 2 and 5. Estradiol admin-

istered to lambs was shown to increase the length of trabecular bone and also the amount of medullary bone. Mass spectrographic analysis of blood and milk Ca showed that there was no isotope effect in the secretion of Ca from blood to milk. Paper electrophoresis of  $\text{Ca}^{45}$ -labeled blood showed that all Ca in blood serum migrated as Ca ion. Similar studies on milk revealed the presence of large amounts of protein-bound or other colloidal Ca which exchanged only slowly with ionized Ca. In addition to the usual effects of Protamone on milk production, it was shown that this substance decreased the ability of the cow's thyroid to pick up  $\text{I}^{131}$ , of particular interest was the rapid return to normal of the thyroid function shortly after Protamone feeding was stopped. Data are tabulated on the clinical and pathological response of burros subjected to daily dosages until death of whole-body  $\gamma$  radiation at the following levels: 400 r/day, 200 r/day, 100 r/day, 50 r/day and 25 r/day. Specific reports are included which discuss the suppression of the gonadotropin principles by whole-body irradiation of the rabbit. Also presented are data which demonstrate the alteration of thyroid function and the reduction of serum alkaline phosphatase by whole body irradiation of the burro. (For preceding period see ORO-98.) (auth)

2736

Atomic Energy Project, Univ. of Rochester  
THE EMPIRICAL RELATION BETWEEN TIME AND INTENSITY OF APPLIED THERMAL ENERGY IN PRODUCTION OF 2+ BURNS IN PIGS. George Mixter, Jr. Mar. 2, 1954. 11p. Contract W-7401-eng-49. (UR-316)

The combined experience of several investigators in this laboratory is cited to show that within the limitations of experimental conditions the 50% effective radiant exposure required to produce a 2+ burn on Chester White pigs may be given by the alternative expressions  $Q_c = 4.39 t^{0.224}$  or  $Q_c = 6.73 H^{-0.289}$  where  $Q_c$  = critical energy of 50% effective radiant exposure for 2+ burn ( $\text{cal/cm}^2$ ),  $H$  = irradiance ( $\text{cal/cm}^2/\text{sec}$ ),  $t$  = time of exposure (sec). (auth)

## RADIATION EFFECTS

2737

Brookhaven National Lab.  
SEX-LINKED LETHAL MUTATIONS INDUCED BY THERMAL NEUTRONS IN MALE AND FEMALE DROSOPHILA MELANOGASTER. R[obert] C. King and Eunice M. Wood. [1953] 28p. (BNL-1778)

Irradiation with thermal neutrons produces sex-linked recessive lethal mutation and loss and fragmentation of X-chromosomes in spermatozoa and oöcytes of *Drosophila melanogaster*. The recessive lethal mutation rate/dosage relation appears to be linear for sperm up to the highest dosage ( $4.6 \times 10^{13} \text{ n}_{\text{th}}/\text{cm}^2$ ). The relation is also linear in oöcytes for doses up to  $3.5 \times 10^{13} \text{ n}_{\text{th}}/\text{cm}^2$ , but this linearity may be fortuitous. The sex-linked lethal rate declines in successive batches of eggs laid after treatment and would reach the control rate in eggs laid two weeks after treat-



ment. The initial mutation rate appears similar to the rate for spermatozoa. It is inferred that the decline in the sex-linked lethal frequency in females may be due to a decreased point mutation rate in eggs immature at the time of treatment, and that a portion of the point mutations are unrelated to breakage. (auth)

\*2738

Los Alamos Scientific Lab.

BIOLOGICAL EFFECTIVENESS OF 14 MEV NEUTRONS! SPLEEN AND THYMUS WEIGHT LOSS IN MICE AS THE BIOLOGICAL INDICATOR. Payne S. Harris, L. Edward Ellinwood, E. C. Anderson, Rowland W. Davis, William Schweitzer, and Phyllis Sanders. Dec. 1953. 16p. Contract W-7405-eng-36. (LA-1629)

Atrophy of the spleens and thymuses of CF1 female mice has been used as a test system for the determination of the biological effectiveness of 14-Mev neutrons compared with that of 250-kvp x rays. The results showed that a dosage of  $1 \times 10^8$  n/cm<sup>2</sup> was equivalent to 1 r of x rays. On the basis of rep calculated from theoretical single collision curves, the data showed that the RBE of 14-Mev neutrons was approximately 1.6. Therefore, the RBE of the 7-Mev recoil protons must be between 1 and 2 for the biological indicator used in this study. (auth)

2739

Atomic Energy Project, Univ. of Rochester  
THE EFFECT OF SINGLE VS. DIVIDED DOSES OF X-IRRADIATION ON SURVIVAL OF RATS. John B. Hursh, Florence Van Slyke, and George Casarett. Mar. 16, 1954. 14p. Contract W-7401-eng-49. (UR-317)

Survival experiments have been performed on male rats which demonstrate that the average shortening of life of the 60-day survivors of a single 600-r dose of x irradiation, equal to approximately 19 per cent, is significantly greater than the average life shortening produced by a total dose of 600 r divided into either 10 daily doses of 60 r per day or 30 daily doses of 20 r per day. (auth)

2740

Atomic Energy Project, Univ. of Rochester  
USE OF A TEST DOSE TO ESTIMATE LIFE SHORTENING PRODUCED IN RATS BY A SINGLE DOSE OF X-IRRADIATION. John B. Hursh, Florence Van Slyke, and George Casarett. Mar. 16, 1954. 15p. Contract W-7401-eng-49. (UR-318)

An experiment has been performed on male rats in which the 60-day survivors of a single dose of x irradiation equal to 650 r were tested by a second dose and an LD<sub>50</sub> of 548 r was arrived at. The reduction in LD<sub>50</sub> is believed to be caused by an irreparable injury produced by the initial dose and to reflect the reduction in survival established in earlier experiments as a consequence of high single dose irradiation. A hypothesis is referred to which requires that the percentage reduction in LD<sub>50</sub>, as compared to the LD<sub>50</sub> of unirradiated rats of the same age, should equal the percentage reduction in expected survival time. The experimental data on high single doses do not appear to fulfill this requirement. (auth)

2741

Atomic Energy Project, Univ. of Rochester  
INFLUENCE OF DIET ON SURVIVAL OF RATS FOLLOWING WHOLE BODY X-IRRADIATION OR POLONIUM INJECTION. Thomas R. Noonan and J. N. Stannard. Mar. 23, 1954. 12p. Contract W-7401-eng-49. (UR-320)

The 30-day mortality of rats following either 625 roentgens of whole-body x irradiation or the intravenous injection of 38 microcuries of polonium per kilogram body weight is not significantly changed by feeding synthetic diets with either 25% casein and 32% fat or 10% casein and 5% fat as compared to a standard Fox Chow diet. (auth)

2742

Naval Radiological Defense Lab.

ALTERATIONS IN ORGAN AND BODY GROWTH OF RATS FOLLOWING DAILY EXHAUSTIVE EXERCISE, X IRRADIATION, AND POST-IRRADIATION EXERCISE. D. J. Kimeldorf and S. J. Baum. Dec. 23, 1953. 24p. (USNRDL-427)

Male rats were subjected to the stress of repeated exhaustive swimming exercise or to several doses of x rays or to various numbers of exhaustive swimming trials after irradiation. A quantitative analysis was made of the body weight and the weights of nine organs at various intervals after imposition of the experimental condition. The body weight, and the gluteus maximus, kidney, and thymus weights were reduced while the adrenal weight was increased in animals subjected to daily exhaustive exercise or exposed to x rays. The spleen and heart were enlarged on particular days of sacrifice following exercise whereas they were reduced with most doses of x rays. The testis and pituitary weights were decreased by irradiation but not by exhaustive exercise. In general, changes following irradiation are related to the x-ray dose and are prompt, whereas the changes with repeated exhaustive exercise are accumulative and dependent upon the number of exercise trials. When irradiated animals are exercised to exhaustion the initial organ weight responses are predominantly those following irradiation and they are not markedly increased by exercise. However, repeated exhaustive exercise tends to sustain the earlier radiation changes and depress recovery from irradiation. It is suggested that the inability of irradiated animals to cope with the additional stress of repeated exhaustive exercise is the cause of the increased mortality among animals which are exercised after irradiation. (auth)

2743

PREVENTION OF TRICHINOSIS BY GAMMA IRRADIATION OF PORK AS A PUBLIC HEALTH MEASURE. S. E. Gould, H. J. Gomberg, and F. H. Bethell (Univ. of Michigan, Ann Arbor and Wayne Univ. Coll. of Medicine, Detroit, Mich.). *Am. J. Public Health* 43, 1550-7(1954) Dec.

The extent of trichinosis in the United States, symptoms of the disease, and treatment and prognosis are discussed briefly. Present methods of control are reviewed. Gamma irradiation of raw pork is considered as a method of prevention, and advantages of radiation treatment are summarized. (C.H.)

2744

A BOX FOR SURFACE IRRADIATION OF LABORATORY ANIMALS WITH BETA RAYS. G. J. Neary and M. E. J. Young (Atomic Energy Research Establishment, Harwell, Berks. England. *Brit. J. Radiol.* 27, 195-8(1954) Mar.

A method of surface irradiation of laboratory animals with  $\beta$  rays by use of a large enclosure of active material is described. Constructional details of the apparatus are given. (auth)

2745

THE EFFECTS OF TUMOR GROWTH AND X-RADIATION ON THE INCORPORATION OF RADIOCARBON FROM 4-AMINO-5-IMIDAZOLECARBOXAMIDE-C<sup>14</sup> INTO NUCLEIC ACIDS. Gaylord M. Conzelman, Jr., H. George Mandel, and Paul K. Smith (George Washington Univ. School of Medicine, Washington, D. C.). *Cancer Research* 14, 100-2(1954) Feb.

The incorporation of the purine precursor, 4-amino-5-imidazolecarboxamide, into the nucleic acid purines isolated from the livers of sarcoma-bearing mice was found to be higher than into those of the livers of control mice. In mice having previously received a total-body x radiation of 400 r, the incorporation of 4-amino-5-imidazolecarbox-



amide into the PNA purines was higher and into DNA purines was slightly lower than the corresponding values in control mice. (auth)

2746

THE PROBLEM OF THE MECHANISM OF THE ACTION OF PENETRATING RADIATION ON THE SYNTHESIS OF NUCLEOPROTEIDS IN THE SPLEEN. A. M. Kuzin and E. V. Budilova (Inst. of Biological Physics). Doklady Akad. Nauk S.S.S.R. 91, 1183-6(1953) Aug. 11. (In Russian)

Maximum inclusion of  $P^{32}$  into the protein fraction of the rat spleen and maximum suppression of this inclusion by irradiation immediately preceding injection of  $P^{32}$  phosphate occurred 19 to 20 hrs after the injection. Irradiation of the head of rats with x rays (1000 r) had little effect on the inclusion of  $P^{32}$  into spleen nucleoproteids. Suppression of  $P^{32}$  inclusion by 60 to 65% occurred when the spleen was irradiated directly with x rays (1000 r), but the rest of the body shielded with lead. Suppression by 20% occurred when the spleen was shielded with lead, but the rest of the body irradiated. (J.S.R.)

2747

THE EFFECT OF X RAYS ON THE MACROMOLECULAR ORGANIZATION OF ESCHERICHIA COLI. Daniel Billen and Elliot Volkin (Oak Ridge National Lab., Tenn.). J. Bacteriol. 67, 191-7 (1954) Feb.

Data are presented from studies of the effects of x irradiation on the structure of the macromolecular components of *E. coli*, as determined with the aid of the analytical ultracentrifuge and by chemical analysis. (C.H.)

2748

EFFECT OF IONIZING IRRADIATION ON INFRARED SPECTRA OF THE BONE MARROW IN RATS. H. P. Schwarz, H. E. Riggs, C. Glick, J. McGrath, R. Childs, E. Bew, Jr., and F. Stone (Philadelphia General Hospital, Penna.). J. Phila. Gen. Hosp. 4, 165-8(1953) Dec.

Infrared spectra of bone marrow are described, and the absorption bands of the bone marrow in the  $8.1\text{-}\mu$  to  $11\text{-}\mu$  region are assigned to nucleic bands. X-ray irradiation produces changes of the infrared spectrum of the bone marrow as a result of a considerable decrease of the nucleic acid content. It is believed that further development of this technique will permit quick and reliable estimations of nucleic acids in bone marrow. It is thought that such a procedure may be an important supplement of cytologic techniques in the study of irradiation injury. (auth)

2749

RADIATION STERILIZATION. VI. RELATIVE MERITS OF CATHODE RAYS AND GAMMA RADIATIONS. Samuel A. Goldblith and Bernard E. Proctor (Massachusetts Inst. of Tech., Cambridge). Nucleonics 12, No. 2, 32-5 (1954) Feb.

The relative merits of  $\beta$  particles and  $\gamma$  rays are compared for use in radiation sterilization when beams of both radiations are of sufficient intensity for sterilization purposes. Problems of ionization distribution and bactericidal effects are discussed for both types of radiation. It is pointed out that while  $\gamma$  rays can provide more uniform distribution of energy in irradiated material, the efficiency of energy in irradiated material, the efficiency of utilization is much lower than for  $\beta$  particles. (C. H.)

## RADIATION HAZARDS AND PROTECTION

2750

MAXIMUM PERMISSIBLE CONCENTRATION OF RADIOISOTOPES IN FOOD, WATER AND AIR AND MAXIMUM PERMISSIBLE EQUILIBRIUM AMOUNTS IN THE BODY. Karl Z. Morgan (Oak Ridge National Lab., Tenn.). Acta Radiol. 41, 30-46(1954) Jan.

Values are given of maximum permissible body burden,

Q, and maximum permissible concentration, MPC, in air and water of some 70 radioisotopes. These values are published in a handbook prepared by the National (U. S.) Committee on Radiation Protection. In a few cases the values chosen are based on human experience, but in most cases they are calculated, using data from animal experiments. The value of Q is considered to be the microcuries of a radioisotope deposited in the total body that will deliver 0.3 rem per week to the critical organ, i. e., the one receiving the radioisotope that results in the greatest over-all damage to the body. The MPC values are the concentrations of the radioisotopes in air or water that if used exclusively for an extended time will lead to an accumulation, Q, in the body. In most cases considered, equilibrium is reached in a few weeks. MPC values for air and water to be used in an emergency are given also. A large dose of ionizing radiation is delivered to tissue in close proximity to an airborne particle of high specific activity that becomes fixed in living tissue. In setting the MPC values for air one would like to know if such localized radiation increases the probability of tumor occurrence. (auth)

2751

DETERMINATION OF THE RADIATION HAZARDS FROM A 1.5 MEV HIGH VOLTAGE ACCELERATOR. Katarina Ahnlund (Nobel Inst. of Physics, Stockholm). Arkiv Fysik 7, 149-53(1954).

Intensities of the electromagnetic radiation and neutrons in the neighborhood of the 1.5-Mev high voltage accelerator have been measured and results are presented. (L.M.T.)

2752

SAFEGUARD CONSIDERATIONS FOR NUCLEAR POWER PLANTS. H. Hurwitz, Jr. (Knolls Atomic Power Lab., Schenectady, N. Y.). Nucleonics 12, No. 3, 57-61(1954) Mar.

Methods for estimating the energy released in a nuclear accident and for evaluating the dangers to the public from dispersed fission products resulting from such an accident are reviewed. (C.H.)

## RADIOTHERAPY

2753

SKIN EFFECTS OF COBALT 60 TELECURIE THERAPY. C. C. Burkell, T. A. Watson, H. E. Johns, and R. J. Horsley (Cancer Clinic, Saskatoon, Saskatchewan). Brit. J. Radiol. 27, 171-6(1954) Mar.

Clinical experiments with open- and closed-end applicators, using the  $Co^{60}$  telecurie unit, have been described. These experiments indicate that the radiation delivered to the surface of the skin is very important in producing a skin reaction. Consequently, to minimize skin reactions from supervoltage sources, the build-up ratio in the first few mm of tissue should not be destroyed by having closed ends on the applicators. The skin reactions, in general, have been much less with  $Co^{60}$  telecurie therapy than with conventional x radiation, even though higher tumor doses and fewer fields were usually employed. (auth)

2754

DESIGN AND PERFORMANCE OF A PORTABLE IRRADIATION UNIT. L. G. Stang, Jr., G. Strickland, A. C. Rand, and G. Selvin (Brookhaven National Lab., Upton, N. Y.). Nucleonics 12, No. 3, 62-3(1954) Mar.

The  $Co^{60}$  source is attached to one end of a rod that slides along the axis of a trunion-mounted shield on casters. By rotating the trunion either a horizontal or a vertical beam can be obtained. The intensity and uniformity of the beam are discussed briefly. (A.G.W.)



2755

COSTS AND SAFE OPERATION OF MODIFIED IRRADIATION UNIT. James E. McLaughlin, Jr. and Hanson Blatz (U. S. Atomic Energy Commission, New York). *Nucleonics* 12, No. 3, 63-6 (1954) Mar.

Construction details and cost factors are presented for a portable 200- to 500-r Co<sup>60</sup> irradiation unit with special emphasis on shielding for the unit. (C.H.)

# TRACER APPLICATIONS

2756

Brookhaven National Lab.

THE EFFECT OF YEAST ON PHOSPHORUS UPTAKE BY *DROSOPHILA*. R[obert] C. King. [1953] 9p. (BNL-1775)

A study was made of the effect of five yeast species upon phosphorus uptake by adults of two species of *Drosophila*. It was found that phosphorus uptake by both species is increased on medium containing live yeast. The rate is increased more in females than in males. Phosphorus uptake is sometimes strikingly different for flies of different species feeding on the same yeast. (auth)

2757

Oak Ridge National Lab.

THE ROLE OF ATOMIC ENERGY IN AGRICULTURAL RESEARCH. PROCEEDINGS OF THE FOURTH ANNUAL OAK RIDGE SUMMER SYMPOSIUM, AUGUST 25-30, 1952. C. L. Comar and S. L. Hood, comps. Oak Ridge National Lab. and Oak Ridge Inst. of Nuclear Studies. Jan. 1953. 492p. (TID-5115)

Papers by various authors were presented on the following subjects: agricultural radiobiology and the national welfare; general outlook on isotope utilization; nuclei and radioactivity; instrumentation for, and design of laboratories for animal and agricultural research; C<sup>14</sup> sample preparation and counting techniques; isotope methodology and miscellaneous agricultural applications; isotope studies with trace elements in animal nutrition; applications of isotope-labeled vitamin B<sub>12</sub>; inorganic sulfur in the synthesis of protein in the rumen from non-protein sources; skeletal metabolism studies with radiocalcium; C<sup>14</sup> studies in animals and health hazards; milk ingredient formation studied with C<sup>14</sup> as tracer; C<sup>14</sup> studies in photosynthesis and translocation; C<sup>14</sup> studies on organic acid metabolism in plants; ion exchange as a tool for studying plant carbohydrates; use of isotopes in mineral nutrition; kinetic exchange studies on residual phosphates in calcareous soils with P<sup>32</sup>; ion absorption by plant roots; use of P<sup>32</sup> in plant root studies; ecological effects of radioactive effluents. (A.G.W.)

2758

A NON-LEACHING TECHNIC FOR AUTORADIOGRAPHY. John C. Gallimore, E. C. Bauer, and George A. Boyd (Oak Ridge Institute of Nuclear Studies, Tenn.). *Stain Technol.* 29, 95-8(1954) Mar.

A paraffin ribbon is fastened on a perforated metal plate having a rectangular hole wide enough to allow the ribbon to be suspended freely. The desired section is centered over the hole and straightened by softening the paraffin over a hot plate and blowing gently on the section. The section is then cut loose on the end of a rubber stopper under a safelight and pressed against the albuminized photographic emulsion. Mayer's albumin does not affect the sensitivity or produce chemical fog in the emulsion. (auth)

2759

LOCALIZATION OF BRAIN TUMORS AND OTHER INTRACRANIAL LESIONS WITH RADIOACTIVE IODINATED HUMAN SERUM ALBUMIN. Howard S. Dunbar and Bronson S. Ray (New York Hospital-Cornell Univ. Medical Coll., New York). *Surg. Gynecol. Obstet.* 98, 433-6 (1954) Apr.

Results are reported in the use of radioactive iodinated human serum albumin for the localization of brain tumors and other intracranial lesions. The correct prediction was made in 76 out of 100 cases reported. (C.H.)

# CHEMISTRY

2760

North American Aviation, Inc.

THE REDUCTION OF THE SOLUBILITY OF BISMUTH TRICHLORIDE IN LIQUID BISMUTH BY SOME INORGANIC CHLORIDES. T. H. Inatomi and D. D. Cubicciotti. May 25, 1953. Decl. with deletions Mar. 23, 1954. 14p. Contract AT-11-1-GEN-8. (AECD-3623; NAA-SR-233)

An experimental investigation has been made of the effects of additions of KCl, NaCl, and PbCl<sub>2</sub> on the solubility of BiCl<sub>3</sub> in liquid Bi. The above salts, in the order listed, reduce the chloride concentration in the bismuth phase. For example, with equimolar NaCl and BiCl<sub>3</sub>, the equilibrium concentration of chloride (expressed as BiCl<sub>3</sub>) in the bismuth phase at 500°C is less than 5 per cent of the value with pure BiCl<sub>3</sub>. (auth)

2761

Purdue Univ.

METAL ION CHELATE COMPLEXES. PROGRESS REPORT COVERING PERIOD FEBRUARY 1, 1953 TO FEBRUARY 1, 1954. 32p. Contract AT(11-1)-160. (AECU-2825)

The investigation of the Ru-bipyridine complexes was concerned with characterizing the species which appeared in solution and postulating a mechanism for the formation of Ru(bipy)<sub>3</sub><sup>2+</sup>. The stability of Cu polyamine complexes were demonstrated by the Bjerrum technique. The Co complex of 2-nitroso-1-naphthol-4-sulfonic acid has greater stability than the corresponding Ni complexes, a reversal of the normal relationships of Co-Ni systems. The formation of osmium-bipyridine complexes was attempted in aqueous solution, as well as the Cr polyamine complexes. A description is given of the arrangement for making magnetic susceptibility measurements. (J.S.R.)

2762

Colorado Univ.

STUDY OF THE RELATION OF SPECTRUM, CONSTITUTION, AND ENVIRONMENT OF SOME LUMINESCING SUBSTANCES. FINAL REPORT FOR JANUARY 1, 1953 TO DECEMBER 31, 1953. Univ. of Colo. and Univ. of Colo. Engineering Experiment Station. 82p. Contract DA-23-072-ORD-297. (NP-5102)

A standard instrumental procedure has been developed for the investigation of the fluorescence spectra of solutions. A series of substituted diphenyls was investigated with the hope of relating emission spectra and molecular structure. Results so far obtained are inconclusive. A study of the fluorescence activities exhibited by systems containing p-terphenyl, α-naphthylphenyl oxazole, and diphenyl oxazole in toluene solutions has been carried out with the intent of more fully describing energy transfer mechanisms. Numerous microphotometer tracings are presented showing the progress in this study. In conjunction with the above, preliminary studies upon phosphors in solid solution have been made. It is thought that, when fully developed, a relationship between molecular collisions and the phenomenon of energy transfer may be determined. It has been shown that phosphorescence of selected organic compounds can be investigated by several procedures, using phosphors in partially dehydrated boric acid glass plates. A phosphoroscope



has been built which can be used either for recording phosphorescence on color film or on spectrographic plates. A method permitting the use of color film in a 35-mm camera, for the estimation of phosphorescence at restricted wavelength bands (use of definite band filters) has been described, and typical results have been tabulated. A series of reproductions of densitometer tracings of phosphorescence as recorded by the spectrograph is presented. The necessary modifications for the adaptation of the phosphoroscope to spectrometric use are described. Special attention is given to those tracings which are made for the same substances as were studied in the case of the use of color film. (auth)

2763

Illinois Univ.

## LOWER OXIDATION STATES IN LIQUID AMMONIA.

FINAL REPORT [FOR] FEBRUARY 1, 1951 TO JANUARY 31, 1954. H. A. Laitinen. 47p. Contract Nonr-21900. (NP-5113)

Hydrazine and water are polarographically inert in liquid ammonia solution at mercury and platinum electrodes. A neutral solution of chloramine in liquid ammonia may be prepared by the passage of chlorine into a suspension of sodium amide. Many other preparative methods lead to contamination by ammonium salts. Chloramine yields a well-defined reduction wave at dropping mercury and rotating platinum electrodes. Observation of the diffusion current is a convenient means of following changes in the concentration of chloramine in liquid ammonia solutions. Unlike the alkali metal cations whose behavior it parallels at a mercury electrode, the ammonium ion is reducible at a platinum electrode in liquid ammonia at  $-78^{\circ}\text{C}$ . The use of a rotating platinum electrode in liquid ammonia is described. The electron electrode was used as reference. Under polarographic conditions, solutions of chloramine in liquid ammonia are unstable at  $-36^{\circ}\text{C}$ , decomposing with a half life of the order of one or two hours. At  $-78^{\circ}\text{C}$ , such solutions are stable for days. Hydrazine accelerates the decomposition. The kinetics of chloramine decomposition in liquid ammonia are partially explicable in terms of the following autocatalytic mechanism:  $\text{NH}_2\text{Cl} + 2\text{NH}_3 \rightarrow \text{N}_2\text{H}_4 + \text{NH}_4^+ + \text{Cl}^-$ ,  $\text{NH}_2\text{Cl} + \text{N}_2\text{H}_4 \rightarrow \text{N}_2\text{H}_2 + \text{NH}_4^+ + \text{Cl}^-$ , and  $\text{NH}_2\text{Cl} + \text{N}_2\text{H}_2 \rightarrow \text{N}_2 + \text{NH}_4^+ + \text{Cl}^-$ . The electroreduction process of chloramine is a two-electron process. The interference between this electrode process and that of ammonium ion reduction gave rise to earlier reports of a single electron reduction. (auth)

2764

Naval Research Lab.

FRictionAL BEHAVIOR OF POLYETHYLENE, POLYTETRAFLUOROETHYLENE, AND HALOGENATED DERIVATIVES. R. C. Bowers, W. C. Clinton, and W. A. Zisman. May 19, 1953. 23p. (NRL-4167)

The static and kinetic frictional properties of a group of unplasticized linear high polymers and copolymers have been investigated in a Bowden-Leben "stick-slip" machine. These plastics were derivatives of polyethylene containing various proportions of fluorine or chlorine. Friction measurements were made for steel sliding on polymer, polymer on polymer, and polymer on steel, with two types of polymer surfaces. The results showed that the substitution of chlorine for hydrogen in polyethylene caused an increase in friction, and that the substitution of fluorine caused a decrease. The effect of chlorine was found to predominate when both fluorine and chlorine were substituted. The major component of the frictional force for each plastic, except for polytetrafluoroethylene, is believed to be the force required to shear the bulk plastic. Transfer of plastic occurs for some sliding combinations, and the orientation of the transferred material during sliding indicates that the

possibility of some shearing at the plastic-metal interface cannot be discounted. The uniquely low coefficient of friction for polytetrafluoroethylene is shown to be good evidence that for this plastic, shearing in depth must be only a minor component of the frictional force. The frictional measurements of thin films of the polymers on steel showed that the frictional force was always much less than for a bulk piece. A good approximation of  $\mu_s$  for very thin films could be calculated by multiplying  $\mu_s$  for the bulk plastic by the ratio of the yield pressure of the plastic to the yield pressure of the substrate. The ease of material transfer combined with low shear strength are confined to polyethylene and polytetrafluoroethylene. The additional properties of low adhesion and heat stability make the latter more suitable for many applications of dry lubricants. (auth)

2765

Metals Research Lab., Carnegie Inst. of Tech.

ELECTROCHEMICAL STUDIES OF NON-AQUEOUS MELTS. QUARTERLY PROGRESS REPORT FOR PERIOD ENDING JANUARY 5, 1954. R. F. Mehl and G. Derge. May 12, 1954. 30p. Contract AT(30-1)-1024. (NYO-3696)

The determination of the current efficiency in the electrolysis of  $\text{CuCl}-\text{CuS}$  systems was made by measuring cathode gain and anode weight loss. The surface tension of pure  $\text{CuCl}$  and  $\text{Cu}_2\text{S}$  and two of their mixtures was determined by the maximum bubble pressure method. A study was made of the electrolysis of  $\text{CaO}-\text{Al}_2\text{O}_3-\text{SiO}_2$  slags containing S. (For preceding period see NYO-3695.) (J.E.D.)

2766

## GMELIN'S HANDBOOK OF INORGANIC CHEMISTRY.

SYSTEM NO. 40. ACTINIUM AND ITS ISOTOPES ( $\text{MsTh}_2$ ). L. Gmelin. Translated by Gifford A. Young from p.1-82 of *Gmelins Handbuch der Anorganischen Chemie. System Nr. 40. Actinium und Isotope (MsTh<sub>2</sub>)*. 8. Aufl. Verlag Chemie, Berlin, 1942. 211p. (AEC-tr-1734)

The physical, chemical, and nuclear properties of Ac, obtained from a literature survey up to Jan. 1, 1940, are outlined in some detail. Its production from ores and separation from various impurities are discussed. A special section is devoted to the properties and purification of  $\text{Ac}^{228}$ . (J.S.R.)

2767

## GMELIN'S HANDBOOK OF INORGANIC CHEMISTRY.

SYSTEM NO. 12. POLONIUM AND ITS ISOTOPES. L. Gmelin. Translated from p.1-137 of *Gmelins Handbuch der Anorganischen Chemie. System Nr. 12. Polonium und Isotope*. 8. Aufl. Verlag Chemie, Berlin, 1941. 196p. (N-2167; M3-D485)

2768

BRITAIN'S ATOMIC FACTORIES; THE STORY OF ATOMIC ENERGY PRODUCTION IN BRITAIN. K. E. B. Jay. London, Her Majesty's Stationery Office, 1954. 100p.

The production of fissionable materials in Britain is described, including the design of the factories, the separation processes used, the health safeguards, and the organization of the British Division of Atomic Energy Production. (J.S.R.)

2769

EXAMINATION OF THE IODOFORM AND SCHMIDT REACTIONS OF ACETONE-1- $\text{C}^{14}$  FOR ISOTOPE EFFECTS. Gus A. Ropp, William A. Bonner, Marion T. Clark and Vernon F. Raaen (Oak Ridge, National Lab., Tenn.). *J. Am. Chem. Soc.*, 76, 1710-11 (1954) Mar. 20.

The iodoform and Schmidt reactions of acetone-1- $\text{C}^{14}$  have been carefully repeated to determine the isotope effects. No noticeable intramolecular or intermolecular isotope effect was found in the iodoform reaction. In the Schmidt reaction small intramolecular and intermolecular



isotope effects in the usual direction were observed instead of the reverse intramolecular isotope effect previously reported. (J.S.R.)

2770

**THORIUM CITRATE COMPLEXES, THEIR COMPOSITION, STRUCTURE AND BEHAVIOR.** M. Bobtelsky and B. Graus (Hebrew University, Jerusalem, Israel). *J. Am. Chem. Soc.* **76**, 1536-9 (1954) Mar. 20.

The complex compounds which exist in heterogeneous as well as homogeneous systems of thorium and citrate in acid, neutral, and alkaline solutions were studied. The phenomena observed may be accounted for as follows. A soluble complex of the composition  $[\text{Th}_2\text{C}_6\text{H}_5\text{O}_7]_2$  is formed in water solution (pH  $\sim 3.0$ ). In 50% alcoholic solution a soluble complex of the composition  $[\text{ThCi}_2]_2$  is obtained (pH  $\sim 3.0$ ). The insoluble compound has the composition  $[\text{ThCi}]_n$  and is soluble quantitatively in an excess of sodium citrate. At high pH's, the soluble  $[\text{Th}_2\text{C}_6\text{H}_5\text{O}_7]_2$  is probably transformed into  $[\text{Th}_2\text{C}_6\text{H}_5\text{O}_7]^{4-}$ . The insoluble  $[\text{ThCi}]_n$  is soluble in sodium hydroxide (pH  $\sim 8.0$ ). (auth)

## ANALYTICAL PROCEDURES

2771

Atomic Energy Research Establishment, Harwell, Berks (England)

**THE EXTENT OF THE FAST NEUTRON EFFECT ON THE DETERMINATION OF SODIUM IN ALUMINIUM BY ACTIVATION IN THE HARWELL PILE.** L. Salmon. Jan. 13, 1954. 5p. (AERE-C/R-1324)

Upon irradiation of aluminum in the center of BEPO, the reaction  $\text{Al}^{27}(\text{n},\alpha)\text{Na}^{24}$  takes place thus introducing spurious sodium activity when determining the sodium content of aluminum. This is shown to be equivalent of 81 ( $\pm 6\%$ ) ppm of sodium in aluminum. (auth)

\*2772

Ames Lab.

**SPECTROPHOTOMETRIC DETERMINATION OF THORIUM WITH THE TRISODIUM SALT OF 2-(2-HYDROXY-3,6-DISULFO-1-NAPHTHYLAZO)-BENZENEARSONIC ACID AND SOME PROPERTIES OF COMPLEXES INVOLVED.** Carol H. Byrd and Charles V. Banks. June 1953. 96p. [Contract W-7405-eng-82]. (ISC-456)

The sodium salt of 2-(2-hydroxy-3,6-disulfo-1-naphthylazo)-benzenearsonic acid (thorin) has been extensively employed as a reagent for the spectrophotometric determination of thorium in recent years. In this work, an examination of some properties of the complexes involved has been initiated. An investigation of the change in the absorption spectrum of the thorin with pH showed that as the hydrogens are removed from the arsono group the equilibrium is shifted toward the hydrazone form of the dye. Solutions of the reagent are stable at low pH, but at neutral and high pH values there is a change with time. A time study on a series of solutions prepared according to Job's method of continuous variations was carried out. On standing the absorbance increased slightly at first, then leveled off for several days, and finally a precipitate developed in all solutions in which the molar ratio of thorin to thorium was less than four to one. The precipitate was isolated, dried at  $105^\circ\text{C}$  for several days, and analyzed for thorium, nitrogen, and water. The results showed it to be a compound containing two waters of crystallization in which the molar ratio of thorin to thorium was 1:1. The optimum conditions for the spectrophotometric method were established. Methods for determining from 20 to 2,000 g thorin were developed. A rapid method for the determination of thorium in monazite sands was developed. The procedure involves (1) fusion of the sand with potassium hydrogen fluoride and separation of the insoluble rare earth and thorium fluorides

by centrifugal action, (2) solution of the fluorides in a saturated aluminum nitrate solution acidified with nitric acid, (3) extraction of the thorium into mesityl oxide and re-extraction into water, and (4) the spectrophotometric determination of the thorium in the extract with thorin. (auth)

2773

Ames Lab.

**TITRATION OF BISMUTH WITH ETHYLENEDIAMINE-TETRAACETIC ACID.** James S. Fritz. Mar. 22, 1954. 7p. Contract W-7405-eng-8[2]. (ISC-470)

Existing methods for the titrimetric determination of bismuth are subject to numerous interferences. In the proposed method bismuth is titrated directly with disodium ethylenediaminetetraacetate (Versene) forming a stable, soluble complex. Excess thiourea is added to form a weak complex with bismuth and thus prevent any precipitation before or during the titration. The disappearance of the last yellow color due to this complex marks the end point of the titration. By this procedure bismuth can be accurately titrated in the presence of many other ions including large amounts of lead. (auth)

2774

Knolls Atomic Power Lab.

**ANALYSIS OF Ru-106 IN VEGETATION.** M. R. Kennedy and J. J. Fitzgerald. Mar. 25, 1954. 14p. Contract W-31-109-Eng-52. (KAPL-1052)

A method of vegetation analysis for ruthenium is presented. This method involves the muffling of the vegetation and the reduction of the ruthenium ions by the addition of magnesium powder. The average chemical yield for this analysis is  $91 \pm 11\%$ . (auth)

2775

National Bureau of Standards

**THE DITHIZONATE DETERMINATION OF LEAD IN BERYLLIUM OXIDE AND BERYLLIUM METAL.** Allan R. Eberle and G. J. Petretic. Dec. 1947. 12p. (NBS-C-102; A-2952)

2776

**COLOR REACTION OF THORIUM. 1. ORGANIC REAGENT FOR THORIUM.** V. I. Kuznetsov. Translated by S. A. Reed from *Zhur. Obshchei Khim.* **14**, 914-19(1944). 9p. (AEC-tr-95; AEC-tr-1666; WD-21348)

Benzene-2-arsonic-(1-azo-1)-2-hydroxynaphthalene-3,6-disulfonic acid makes it possible to detect thorium in the presence of rare earths and of other elements as it forms a raspberry-red precipitate with thorium salts. The preparation of benzene-2-arsonic-(1-azo-1)-2-hydroxynaphthalene-3,6-disulfonic acid has been described by way of the linking of diazotized o-aminophenyl-arsonic acid with sodium naphthol disulfonate-2,3,6. (auth)

2777

**TITRATION IN NONAQUEOUS SOLUTIONS: 4. OXIDATION-REDUCTION TITRATION IN A MEDIUM OF ANHYDROUS ACETIC ACID.** O. Tomicek and A. Heyrovsky. Translated from *Chem. Listy* **44**, 245-53(1950). 22p. (AEC-tr-1835)

2778

**A NEW METHOD FOR THE SIMULTANEOUS MICRO-DETERMINATION OF FLUORINE, HYDROGEN, AND CARBON IN ORGANIC COMPOUNDS.** N. E. Gel'man and M. O. Korshun. Translated from *Doklady Akad. Nauk S.S.S.R.* **89**, 685-7(1953). 3p. Available from Associated Technical Services (Trans. RJ-138), East Orange, N. J. (AEC-tr-1836)

The method consists of burning the sample in a stream of  $\text{O}_2$  or air in a quartz tube. H and C are determined in the usual manner, and F is combined with a metal oxide in the combustion tube. The amount of F in the sample is



determined by the change in weight of the oxide. Examples are given. (J.S.R.)

2779

# HYDROGEN DETERMINATION AND LIQUID ANALYSIS WITH A BETA-PARTICLE ABSORPTION APPARATUS.

V. N. Smith and J. W. Otvos (Shell Development Co., Emeryville, Calif.). *Anal. Chem.* **26**, 359-66(1954) Feb.

An apparatus was developed for measuring accurately the absorption of beta particles by liquids; the dependence of absorption upon density and composition was then investigated. Although the method may be used for measurement of density of binary liquid mixtures with an accuracy of  $\pm 0.0002$  g/ml, sensitivity to composition precludes accurate density determination in complex mixtures. This sensitivity to composition, however, makes possible the determination of chemically bonded hydrogen in hydrocarbons or other organic liquids if an independent measurement of density is made. The wt. % hydrogen may be determined with an accuracy of 0.1% absolute using this technique. The application to hydrogen determination will be valuable in laboratories where many determinations must be made daily, because of the speed with which samples may be handled as compared with the usual combustion methods. In the role of a density recorder the instrument may be used for continuous recording of density or composition of flowing liquid streams in plant installations. (auth)

2780

DIRECT PHOTOMETRIC DETERMINATION OF IRON, TITANIUM, AND COPPER IN TANTALUM AND ITS OXIDE. Jane Hastings, T. A. McClarity, and E. J. Broderick (General Electric Co., Pittsfield, Mass.). *Anal. Chem.* **26**, 379-81(1954) Feb.

The work described was undertaken in order to provide rapid chemical methods for the analysis of pure tantalum metal and to furnish data for the calibration curves for spectrographic examination of the material. The spectrophotometric determination of iron by o-phenanthroline was used in the range of 0.002 to 0.030% of iron, of copper by sodium diethyldithiocarbamate in the range of 0.000 to 0.016% of copper, and of titanium by hydrogen peroxide and sulfuric acid in the range of 0.004 to 0.070% of titanium. Calibration data are for each element as obtained with a Beckman DU spectrophotometer. Tedious separations of the elements to be determined are unnecessary, and contamination from the use of large quantities of reagents is avoided. A tenfold gain in time was realized for the analysis of samples of tantalum metal. Precision and accuracy have been greatly improved. (auth)

2781

# FLAME PHOTOMETRIC DETERMINATION OF ALKALI AND ALKALINE EARTH ELEMENTS IN CAST IRON.

Donald F. Kuemmel (Allis-Chalmers Manufacturing Co., Milwaukee, Wis.) and Herman L. Karl (Marquette Univ., Milwaukee, Wis.). *Anal. Chem.* **26**, 386-91(1954) Feb.

A flame photometric method was developed for simultaneously determining calcium, magnesium, sodium, and lithium present in experimental cast irons. The procedure involves dissolution of the sample in hydrochloric acid and removal of the insoluble residue of carbon and silica by filtration, followed by extraction with ether to remove the major portion of the iron. The aqueous extract, after further treatment to remove ether and insoluble matter, is read on the flame photometer with suitable standards. The method is comparable in accuracy and precision to the classical gravimetric techniques and can be handled by inexperienced personnel. The flame photometric determination of magnesium, the principal additive in most forms of nodular cast iron, should be of particular interest to those

laboratories which do not have spectrographic facilities, as it offers a relatively rapid means of analyzing for this element, with elimination of many of the tedious separations and ignitions of gravimetric analysis. (auth)

2782

DETERMINATION OF NITROGEN IN ZIRCONIUM BY MICRO-KJELDAHL STEAM DISTILLATION. J. F. Rodgers, and G. J. Harter (Westinghouse Electric Corp., Pittsburgh, Penna.). *Anal. Chem.* **26**, 395-6(1954) Feb.

A rapid, accurate procedure for determining N in Zr using H. F. Beeghly's method (*Ind. Eng. Chem., Anal. Ed.* **14**, 137-40(1942)) for steel is described. A single determination may be made in a half hour or less. The average deviation from the mean for 50-odd determinations on a Zr sample containing 0.0034% N was  $\pm 0.0007$ . Similar results on a standard sample of Zr containing 0.016% N gave a deviation of  $\pm 0.001$ . (J.A.G.)

2783

CRITICAL FACTORS IN DETERMINATION OF OXYGEN IN TITANIUM BY THE VACUUM-FUSION METHOD. W. M. Albrecht and M. W. Mallett (Battelle Memorial Inst., Columbus, Ohio). *Anal. Chem.* **26**, 401-2(1954) Feb.

A systematic study of various vacuum-fusion methods for the determination of O in Ti is reported. Effectiveness and causes of variations in results are discussed. (J.A.G.)

## CRYSTALLOGRAPHY AND CRYSTAL STRUCTURE

2784

Cornell Univ.

STRUCTURES OF FLUOROCARBONS, ELEMENTARY BORON, AND BORON COMPOUNDS. PROGRESS REPORT [FOR APRIL 1, 1953-MARCH 31, 1954]. J. L. Hoard. Apr. 1, 1954. 8p. Contract AT(30-1)-878. (NYO-3948)

Preliminary structural studies of several fluorocarbons have been made. Two of these, the crystalline hydrate of sodium perfluorosuccinate and crystalline silver perfluorobutyrate, were selected for study. Prospects for a successful determination of structure are relatively good in both cases. Crystals of silver perfluoroacetate and silver perfluorosuccinate offer less hopeful prospects; crystals of perfluorosuccinic acid are still more complex. The structure of the most interesting fluorocarbon,  $C_6F_{12}$ , remains a baffling problem. Data on the unit cell and space group of phenyl boric anhydride are included. (auth)

## DEUTERIUM AND DEUTERIUM COMPOUNDS

2785

PRESSURE-VOLUME-TEMPERATURE RELATIONSHIPS OF LIQUID NORMAL DEUTERIUM. Abraham S. Friedman, Max Trzeciak and Herrick L. Johnston (The Ohio State Univ., Columbus). *J. Am. Chem. Soc.* **76**, 1552-3 (1954) Mar. 20.

Compressibility factors of liquid normal deuterium have been determined at pressures up to 100 atm. and at temperatures between the triple and critical points of  $D_2$ . Isochores, derived from the experimental isotherms, are linear and their slopes are a linear function of the density throughout the range investigated.  $(\partial P/\partial T)_v = -14.1 + (665/V)$ , where the pressure is in atmospheres, the temperature is in degrees absolute, and volume is in cc per mole. (auth)

2786

THE EFFECTS OF DEUTERIUM SUBSTITUTION ON THE RATES OF ORGANIC REACTIONS. III. SOLVOLYSIS RATES AND ARRHENIUS PARAMETERS FOR 2,3-DIMETHYL-2-CHLOROBUTANE AND ITS 3-DEUTERO ANALOG. V. J. Shiner, Jr. (Indiana Univ., Bloomington). *J. Am. Chem. Soc.* **76**, 1603-6 (1954) Mar. 20.



The observations of the effect of the  $\beta$ -deuterium substitution on the solvolysis rates of tertiary alkyl chlorides have been extended to include the case of a tertiary deuterium atom. The solvolysis rate constants in 80% aqueous alcohol at 25° for 2,3-dimethyl-2-chlorobutane and its 3-deutero analog are 8.68 and  $6.76 \times 10^{-6} \text{ sec}^{-1}$ , respectively. The deuterium compound has an activation energy  $580 \pm 70$  calories higher and a log frequency factor  $0.32 \pm 0.03$  unit higher than the hydrogen compound. The order of the isotope rate effect in the series  $-\text{CD}_3$ ,  $-\text{CD}_2-$ ,  $-\text{CD}-$  and the hypothesis of elimination type driving forces suggests a reinterpretation of the effect of  $\beta$ -branching on solvolysis rates which does not involve two conflicting electronic influences. Similarly suggested is a possible reinterpretation of the polar effects of alkyl groups in ionic reactions, customarily explained by hyperconjugation. (auth)

2787

THE PRIMEVAL COSMIC ABUNDANCE OF DEUTERIUM. G. Boato (Univ. of Chicago). *Phys. Rev.* **93**, 640-1(1954) Feb. 1.

Twelve carbonaceous chondrites were analyzed for H and C content, and their isotopic composition was determined mass spectrometrically. The D/H ratios are compared with a standard sample of Lake Michigan water. It was found that most of the water of the chondrites is strongly bound and does not exchange with external water during a long period of time. It is concluded that there is no significant variation of the D content of the chondrites in comparison with that of the earth. (L.M.T.)

#### FLUORINE AND FLUORINE COMPOUNDS

2788

THE VIBRATIONAL SPECTRUM AND MOLECULAR STRUCTURE OF RHENIUM HEXAFLUORIDE. J. Gaunt (Atomic Energy Research Establishment, Harwell, Berks, England). *Trans. Faraday Soc.* **50**, 209-12(1954) Mar.

The infrared and Raman spectra of rhenium hexafluoride have been observed. An interpretation of the spectra has been made along the lines suggested in a previous paper for molecules belonging to the  $O_h$  symmetry group and having totally symmetric octahedral structures. The thermodynamic properties have been calculated on the simple harmonic oscillator approximation. (auth)

#### LABORATORIES AND EQUIPMENT

2789

Atomic Energy Research Establishment, Harwell, Berks (England)

A COLLAPSIBLE DRY BOX OF FLEXIBLE P.V.C. SUPPORTED IN A STEEL FRAME. R. A. G. Welsher. Dec. 9, 1953. 7p. (AERE-E/M-78)

A method of constructing a dry box from flexible P.V.C. complete with suction unit and supported by a tubular steel frame is described, together with a collapsing technique for storage or disposal. Possible lines of development are indicated. (auth)

2790

Atomic Energy Research Establishment, Harwell, Berks (England)

A VACUUM DIFFERENTIAL THERMAL ANALYSIS APPARATUS. J. M. North. Oct. 24, 1949. 7p. (AERE-M/M-16)

An apparatus was built for exploratory work on the phase changes in uranium alloy systems. The principle of operation, the method of construction, and the advantages of the apparatus are indicated. An outline is given of some work carried out using this apparatus. (auth)

#### RADIATION CHEMISTRY

2791

Columbia Univ.

UTILIZATION OF WASTE FISSION PRODUCTS IN CHEMICAL REACTION. W. A. Selke, A. Czikk, and J. Dempsey. Mar. 1, 1954. 8p. Contract AT(30-1)-1187. (NYO-3330)

The utilization of fission products for accelerating reactions in which toxic compounds in dilute aqueous wastes are destroyed has been shown to be of interest. Studies on the oxidation of cyanide showed satisfactory elimination of 30 ppm with a dose of 400,000 rep. Sulfide was eliminated from a solution of 25 ppm  $\text{Na}_2\text{S}$  with a dose of 160,000 rep. Extension of previous studies on irradiation of aqueous benzene solution indicated that oxidation of benzene could be continued beyond the oxygen break by sparging oxygen into the solution being irradiated. (auth)

#### RADIATION EFFECTS

\*2792

Oak Ridge National Lab.

RADIATION STABILITY OF PLASTICS AND ELASTOMERS (SUPPLEMENT TO ORNL-928). C. D. Bopp and O. Sisman. July 23, 1953. 87p. Contract W-7405-eng-26. (ORNL-1373)

Radiation-induced changes in the physical properties of several plastics that were not included in ORNL-928 and the radiation-induced changes in commercial elastomers are reported. In addition, a number of fabrics and some specially prepared materials are examined. For the most part, reactor radiation was used, but other types of radiation are compared with reactor radiation in producing changes in the properties of the materials studied. The effect of the presence of oxygen during irradiation and the effect of time of aging subsequent to irradiation are also studied. The rate of gas evolution and the rate of change in volume are given for many of the materials studied, and a correlation is drawn with the chemical structure. Also, changes in the mechanical properties of the polymers are correlated with their chemical structure. (auth)

2793

THE CROSS-LINKING AND DEGRADATION OF PARAFFIN CHAINS BY HIGH-ENERGY RADIATION. A. Charlesby (Atomic Energy Research Establishment, Harwell, Berks, England). *Proc. Roy. Soc. (London)* **A222**, 60-74(1954) Feb. 23.

$n$ -Paraffins from  $\text{C}_7\text{H}_{16}$  to  $\text{C}_{36}\text{H}_{74}$  and polyethylene polymers (Polythene and Winnothene) have been subjected to atomic pile radiation. For the paraffins there is a decrease in the melting point until, for a radiation dose  $R$ , they no longer melt at temperatures of 160°C or above. At about this same radiation the paraffin is turned into an insoluble gel. The product  $Rn\rho$ , where  $n$  is the number of carbons per atom and  $\rho$  the density, is approximately constant from heptane ( $n=7$ ) to Polythene ( $n\sim 2000$ ), although an anomaly may occur for Winnothene ( $n\sim 250$ ). This indicates that the energy required to form a cross link is approximately independent of chain length. An analysis of published experiments on methane and butane extends this conclusion down to  $n=1$ . The results obtained by earlier workers when paraffinic gases are bombarded with deuterons and  $\alpha$  particles are explained in terms of the crosslinking phenomenon. Solubility measurements give similar values for  $Rn\rho$  in the case of Polythene and Winnothene and show that for every cross link formed, on the average about 0.35 C—C bonds in the main chain are fractured. Similar values are obtained for methane and butane. The energy absorbed per C—H bond fracture is about 12 ev, and the energy per cross link is 24 ev. This corresponds to 0.5% of carbons becoming cross linked per unit radiation, independent of the



physical state (solid, liquid or gaseous) of the irradiated paraffin. The importance of these results, as far as polymerization theory is concerned, is briefly discussed. (auth)

#### RARE EARTHS AND RARE-EARTH COMPOUNDS 2794

Ames Lab.

CONDUCTANCES, TRANSFERENCE NUMBERS, AND ACTIVITY COEFFICIENTS OF SOME RARE EARTH CHLORIDES IN AQUEOUS SOLUTION. James L. Dye and F. H. Spedding. June 1953. 119p. Contract W-7405-eng-82. (ISC-355)

The conductances, transference numbers, and activity coefficients of aqueous solutions of Nd, Dy, Ho, Er, Tm, and Yb chlorides at the equivalence pH were measured at concentrations up to 0.1N. In addition, a new mathematical treatment of the electrophoretic part of the Onsager theory of conductance was carried out. This resulted in better agreement between the theoretical and experimental values of the transference numbers and conductances. The conductances were measured for solutions ranging from 0.003 to 0.1N. The equivalent conductances obeyed the simple Onsager equation up to about 0.0008N and agreed with the new mathematical treatment of Onsager's theory up to about 0.008N. The transference numbers were determined for solutions from 0.01 to 0.1N. The simple Onsager equation predicted much lower transference numbers than were measured, but after mathematical extension the theory agreed with the experimental values much more closely. The conductances and transference numbers both exhibit similar changes with atomic number. The experimental values of both remain nearly unchanged for the first 5 or 6 rare earth chlorides. A relatively large change takes place between  $\text{SmCl}_3$  and  $\text{HoCl}_3$ , and the values remain nearly unchanged for Ho, Er, Tm, and Yb chlorides. The activity coefficients were determined in the concentration range 0.002 to 0.1N. The experimentally obtained coefficients agreed with the predictions of the Debye-Hückel theory with a precision of about  $\pm 0.2\%$ . The values of  $\bar{a}$ , the distance of closest approach of the ions, indicated that the rare earth ion has 1 layer of  $\text{H}_2\text{O}$  molecules which adheres rather firmly to the central ion. These values are larger for the high atomic number rare earth chlorides than for the lower numbers of the series but did not increase or decrease, experimentally, in regular fashion throughout the series. A new mathematical treatment of the electrophoretic part of Onsager's theory of conductance is described, which employs graphical methods to evaluate integrals. This was applied to the conductances and transference numbers of  $\text{NdCl}_3$ ,  $\text{ErCl}_3$ , and  $\text{CaCl}_2$ . The conductances agreed with the experimental values up to about 0.008N, and the transference numbers agreed well enough with the experimental values to explain the large discrepancy which had existed between theory and experiment for those of unsymmetrical electrolytes. (J.A.G.)

2795  
SPECTROGRAPHIC DETERMINATION OF CERTAIN RARE EARTHS IN STAINLESS STEELS. Ellen W. Spitz, Joseph R. Simmler, Byron D. Field, Karl H. Roberts, and Samuel M. Tuthill (Mallinckrodt Chemical Works, St. Louis, Mo.). *Anal. Chem.* 26, 304-7(1954) Feb.

The addition of a mixture of rare earth oxides or metals to molten steel has created an interest in the determination of the residual rare earths in the steel. A spectrographic method using a direct current arc, following electrochemical and chemical separations, has been developed which permits the determination of as little as 50 $\mu\text{g}$  of total rare earths in a 1-g sample of steel. Electrolytic separation with a mercury cathode is used to remove the major inter-

fering components from the sample solution. The less than milligram amounts of cerium, lanthanum, neodymium, and praseodymium which remain in solution are concentrated by precipitation with ammonium hydroxide, using ferric iron as a carrier. The combined hydroxides are dissolved in a minimum of hydrochloric acid, and uranium and sodium chloride are added to serve as the internal standard and as the spectroscopic buffer, respectively. (auth)

2796  
THE VAPOR PHASE HYDROLYSIS OF THE RARE EARTH HALIDES. III. HEAT AND FREE ENERGY OF THE REACTIONS  $\text{PrCl}_3(\text{s}) + \text{H}_2\text{O}(\text{g}) = \text{PrOCl}(\text{s}) + 2\text{HCl}(\text{g})$  AND  $\text{NdCl}_3(\text{s}) + \text{H}_2\text{O}(\text{g}) = \text{NdOCl}(\text{s}) + 2\text{HCl}(\text{g})$ . C. W. Koch and B. B. Cunningham (Univ. of California, Berkeley). *J. Am. Chem. Soc.* 76, 1471-4(1954) Mar. 20. (cf. NSA 6-3536 and 6-6330).

Equilibrium constants for the hydrolysis of  $\text{PrCl}_3(\text{s})$  and  $\text{NdCl}_3(\text{s})$  by water vapor have been determined at various temperatures between 700 and 900°K. Free energy functions based on the experimental data and an estimated  $\Delta C_p$  relation agree with experiment within an average deviation of  $\pm 30$  cal/mole for the praseodymium reaction and  $\pm 10$  cal/mole for neodymium. Calculated thermodynamic constants for the reactions are  $\text{PrCl}_3(\text{s}): \Delta F_{785}^0 = -2.07$  kcal;  $\Delta H_{785}^0 = 21.53$  kcal;  $\Delta S_{785}^0 = 30.07$  e.u.;  $\Delta F_{298}^0 = 13.22$  kcal;  $\Delta H_{298}^0 = 22.98$  kcal;  $\Delta S_{298}^0 = 32.75$  e.u.; and  $\text{NdCl}_3(\text{s}): \Delta F_{785}^0 = -2.88$  kcal;  $\Delta H_{785}^0 = 20.91$  kcal;  $\Delta S_{785}^0 = 30.31$  e.u.;  $\Delta F_{298}^0 = 12.41$  kcal;  $\Delta H_{298}^0 = 22.24$  kcal;  $\Delta S_{298}^0 = 32.99$  e.u. It is pointed out that for the rare earth trichlorides of lanthanum through gadolinium the heats of hydrolysis show an approximately linear dependence upon the reciprocal of the cation radius. (auth)

2797  
THERMOCHEMISTRY OF THE RARE EARTHS. II. LANTHANUM, PRASEODYMIUM, SAMARIUM, GADOLINIUM, ERBIUM, YTTERBIUM AND YTTRIUM. F. H. Spedding and J. P. Flynn (Iowa State College, Ames). *J. Am. Chem. Soc.* 76, 1474-7 (1954) Mar. 20. (cf. NSA, 6-840)

The integral heats of solution of the metals and anhydrous chlorides, in hydrochloric acid solutions, and the hydrated chlorides in water, have been measured at 25°. From these data the standard heats of formation of the anhydrous and hydrated chlorides have been calculated. In addition, estimates have been made of the free energies of formation of the same compounds. (auth)

2798  
INTEGRAL HEATS OF SOLUTION OF SOME RARE EARTH TRICHLORIDES. F. H. Spedding and J. P. Flynn (Iowa State College, Ames). *J. Am. Chem. Soc.* 76, 1477-80 (1954) Mar. 20.

The integral heats of solution of the trichlorides of lanthanum, praseodymium, samarium, gadolinium, erbium, ytterbium and yttrium have been measured in water at 25°. Using the limiting slope given by the Debye-Hückel theory, the data have been extrapolated to infinite dilution. (auth)

#### SEPARATION PROCEDURES

2799  
Columbia Univ.  
CONTINUOUS ION EXCHANGE WITH A COTTON BELT. W. A. Selke and C. H. Muendel. Feb. 15, 1953. 10p. Contract AT(30-1)-1108. (NYO-962)

Work has been carried out to explore the possibility of carrying out continuous ion exchange by means of an endless belt of phosphorylated cotton. The latter material has been found to have an exchange capacity comparable to that of commercial resins; however, when prepared by current methods it shows a somewhat higher internal diffusion resistance. A laboratory scale apparatus has been built and successfully used to concentrate copper solutions. (auth)



2800

Columbia Univ.

ION EXCHANGE RATE STUDIES WITH A CARBOXYLIC EXCHANGER. W. A. Selke, J. E. Borner, and G. G. Ceen. Feb. 15, 1954. 14p. Contract AT(30-1)-1108. (NYO-963)

In the study of mass transfer in an ion exchange bed the concentration of the exchanging ion at the interface of the resin particles and the solution is of great interest. A photometric method has been developed for measurement of the surface concentrations of copper ion on a carboxylic ion exchange resin. It consists of a reflectometer, a photocell, and a potentiometer. It was calibrated against equilibrated samples of resin of known uniform concentration. A chemical rate step in which copper ions taken into the resin are converted to a more colored form of copper-resin compound has been observed and rate constants for the reaction have been calculated. This kinetic step must be considered when the photometric method is applied to the study of ion exchange beds under dynamic conditions. Using the photometric technique, ion exchange in a bed has been followed during the exchange operation. (auth)

2801

Columbia Univ.

ION EXCHANGE RATE MECHANISM IN A DEEP BED. W. A. Selke, B. L. Hoffman, and E. J. Lemanski. Feb. 15, 1954. 12p. Contract AT(30-1)-1108. (NYO-6518)

The shallow bed technique has previously been shown to allow precise evaluation of liquid and solid resistances in ion exchange. The effective solid resistance depends on the rate of exchange. The shallow bed technique has been extended to reproducing typical conditions within an element of a deep bed, where the concentration of the liquid feed to the element increases with time. Under these conditions mass transfer coefficients have been determined for copper-hydrogen exchange with Dowex-50. The rate information obtained by this technique is directly applicable in the rational engineering design of ion exchange equipment. (auth)

2802

Oak Ridge National Lab.

ELUTION CHROMATOGRAPHY WITH THICK FILTER PAPER. W. J. Frierson, P. F. Thomason, and Helen P. Raen. June 30, 1953. Decl. Nov. 4, 1953. 16p. Contract W-7405-eng-26. (ORNL-1549)

A technique for elution chromatography with thick filter paper is reported. The apparatus, a general procedure for its use, and applications of the technique to sample analysis, especially to the separation of mg quantities of U from other elements, are described. (auth)

2803

Chalk River Project (Canada)

TECHNETIUM STUDIES. E. Mizzan. Oct. 8, 1953. 18p. (PDB-101)

Attempts were made to separate technetium from the other relatively long-lived fission product activities by distillation as the volatile  $Tc_2O_7$ . The best distillation medium was found to be concentrated  $H_2SO_4$ . Technetium was isolated by extraction as the tetra phenylarsonium pertechnetate into chloroform. The extracted activity was recovered by backwashing the solvent with concentrated HCl, or by evaporating the solvent and picking up the residual activity with 6N HCl or water. Studies of activity counts for aqueous technetium solutions and the preparation of a spectrographic standard for technetium are also discussed. (auth)

2804

ADSORPTION SEPARATION OF CERIC EARTHS, ESPECIALLY OF ISOTOPES FORMED DURING URANIUM FISSION. (Adsorptionstrennung Der Ceriterden, Im Besonderen Ihrer Bei Der Uranspaltung Entstehenden Isotope). Roland

Lindner. Translated from *Z. Naturforsch.* 2A, 329-32(1947). 13p. (AEC-tr-1848)

An abstract of this paper appears in *Nuclear Science Abstracts* as NSA 1-203.

2805

EXTRACTION OF CATIONS AS SALTS OF FATTY ACIDS. II. ANALYTICAL AND CHROMATOGRAPHIC SEPARATION OF BERYLLIUM FROM IRON AND ALUMINIUM. S. Banerjee, A. K. Sundaram, and Hari D. Sharma (Atomic Energy Commission, Bombay, India). *Anal. Chim. Acta* 10, 256-9(1954) Mar. (In English)

Quantitative extractions of aluminum and ferric ions are carried out in the presence of butyric acid. A method has been given for quantitative extraction of beryllium from aluminum and ferric ion in presence of (ethylene-diamine)tetraacetic acid. Interference has been studied, and interference due to phosphate has been avoided by addition of zirconium salt. The method has been applied to the analysis of beryl. (auth)

2806

ANION-EXCHANGE STUDIES. I. BROMIDE COMPLEXES OF Co(II), Cu(II), Zn(II) AND Ga(III). Rolfe H. Herber and John W. Irvine, Jr. (Massachusetts Inst. of Tech., Cambridge). *J. Am. Chem. Soc.* 76, 987-99(1954) Feb. 20.

The anion-exchange behavior of Zn(II), Cu(II), Ga(III), Co(II), and Ni(II) was studied in hydrobromic acid solutions. On the basis of widely differing adsorbabilities, several separations of these ions from each other in HBr solutions are feasible. With the exception of Ga(III), the anion-exchange behavior of these divalent transition elements in HBr closely parallels their behavior in HCl solutions. (auth)

## SPECTROSCOPY

2807

Cornell Univ.

THE ABSORPTION SPECTRUM OF BERYLLIUM IN THE NEIGHBORHOOD OF THE K-EDGE. R. W. Johnston and D. H. Tomboulia. Mar. 15, 1954. 20p. Contract DA-30-115-ORD-325. (NP-5095)

## SYNTHESES

2808

Brookhaven National Lab.

INTERMEDIATES IN THE SYNTHESIS OF CARBOXYL  $C^{14}$ -LABELED 3-HYDROXYANTHRANILIC ACID. L. S. Cierszko and L. V. Hanks. [1954?] 6p. (BNL-1776)

In the course of the synthesis of carboxyl  $C^{14}$ -labeled 3-hydroxy-anthranilic acid required for biochemical studies of the formation of nicotinic acid, four new compounds have been obtained. This note describes the preparation of 3-methoxy-2-nitrobenzamide, 3-methoxy-2-nitroaniline, 3-methoxy-2-nitroiodobenzene, and 3-methoxy-2-nitrobenzonitrile. (auth)

2809

National Bureau of Standards

THE SYNTHESIS OF  $\alpha$ -D-GLUCOSE-2- $C^{14}$ ,  $\alpha$ -D-MANNOSE-2- $C^{14}$  AND  $\alpha$ -D-GALACTOSE-2- $C^{14}$ . Horace S. Isbell, Harriet L. Frush, and Robert Schaffer. Feb. 1, 1954. 9p. (NBS-3004)

The preparation of 2- $C^{14}$ -labeled sugars from D-arabinose-1- $C^{14}$  and D-lyxose-1- $C^{14}$  is described. A diagram shows the steps of the synthesis and the yields of the products based on the activities of the starting materials (J.S.R.)

2810

Pittsburgh Univ.

PROGRESS LETTER FROM NOVEMBER 1, 1953 TO JANUARY 31, 1954. Robert Levine, Alfred D. Miller, and



Carl Osuch. Feb. 16, 1954. 5p. Contract AT(30-1)-670. (NYO-6032)

The addition of butyllithium to 4-picoline followed by the addition of methyl benzoate gives 4-phenacetylpyridine in 40% yield. 2-Phenacetylpyridine is obtained by the same process if 2-picoline is used. A new method for the synthesis of 2,2'-dipyridyl (the reaction of 2-picolylithium in refluxing pyridine) gives a 39% yield. The synthesis of 2-acetylpyrrole in the presence of a number of Lewis acids as catalysts gives small but encouraging yields. (J.S.R.)

2811

**BIOSYNTHESIS OF C<sup>14</sup>-SPECIFICALLY LABELED CELLULOSE BY *ACETOBACTER XYLINUM*. I. FROM D-GLUCOSE-1-C<sup>14</sup> WITH AND WITHOUT ETHANOL.**

Francis W. Minor, Glenn A. Greathouse, Harold G. Shirk, Anthony M. Schwartz and Milton Harris. (Harris Research Labs., Washington, D. C.). *J. Am. Chem. Soc.* **76**, 1658-61(1954) Mar. 20.

C<sup>14</sup>-Specifically labeled cellulose was biosynthesized by *Acetobacter xylinum* from D-glucose-1-C<sup>14</sup> as the sole labeled carbon source. The presence of ethanol in the medium increased the yield and the quantity of C<sup>14</sup> found in the cellulose. The distribution of C<sup>14</sup> in D-glucose from the bacterial cellulose hydrolysate indicated that approximately 82% of the activity was in position 1 for the cellulose produced from D-glucose-1-C<sup>14</sup> in the ethanol-free medium compared to 70% in that position for the cellulose produced with ethanol present. Positions 3 and 4 contained the remainder of the activity in approximately equal amounts. The cellulose had a lower specific radioactivity than the D-glucose-1-C<sup>14</sup> that was supplied. This result shows that some of the original hexose units are cleaved prior to cellulose formation. Thus, polymerization of the D-glucose as such, without prior chain cleavage, is not the sole mechanism of cellulose biosynthesis by the bacterium. (auth)

2812

**PREPARATION AND PERFORMANCE OF EFFICIENT PLASTIC SCINTILLATORS.** Warren L. Buck and Robert K. Swank (Argonne National Lab., Lemont, Ill.). *Nucleonics* **11**, No. 11, 48-52 (1953) Nov.

Techniques are described for the preparation of plastic scintillators by the polymerization of liquid monomer-fluor solutions. Performance characteristics of the scintillators are discussed. (C.H.)

**TRANSURANIC ELEMENTS AND COMPOUNDS**

2813

Atomic Energy Research Establishment, Harwell, Berks (England)

**THE EMISSION SPECTRUM OF AMERICIUM. PART 1.** R. P. Thorne. Dec. 28, 1953. 11p. (AERE-C/R-1309)

Some two hundred and thirty lines of the emission spectrum of americium have been recorded. The ranges covered were from 2,000 to 10,000 Å using a high-wattage spark unit and from 2500 to 5000 Å by arcing at 3 amps d-c. (auth)

2814

**THE PREPARATION AND SOME PROPERTIES OF PLUTONIUM FLUORIDES.** J. K. Dawson, R. M. Elliott, R. Hurst, and A. E. Truswell (Atomic Energy Research Establishment, Harwell, Didcot, Berks, England). *J. Chem. Soc.*, 558-64(1954) Feb.

The milligram-scale preparation of plutonium trifluoride, tetrafluoride, and possibly two hydroxyfluorides by the reaction of hydrogen fluoride with plutonium dioxide or oxalate is described. Precipitation of plutonium tetrafluoride from dilute aqueous solution gives a hydrate with the molecular weight of 2PuF<sub>4</sub>·5H<sub>2</sub>O; vacuum dehydration of the precipitate at 300° gives plutonium

trifluoride. When plutonium trifluoride is precipitated, sufficient water is trapped in the lattice to give material of composition 4PuF<sub>3</sub>·3H<sub>2</sub>O. Thermogravimetric curves are described for the anhydrous fluorides and the precipitated fluorides. The reaction of plutonium trifluoride with very dry oxygen has been studied, and by measurement of the oxygen pressure developed by the reverse reaction the free energy of formation of plutonium tetrafluoride has been deduced as 400 kcal/mole at 298°K. Plutonium tetrafluoride undergoes disproportionation in vacuum at ca 900° to give the trifluoride and probably the more volatile pentafluoride. (auth)

**TRITIUM AND TRITIUM COMPOUNDS**

2815

**THE MERCURY-PHOTOSENSITIZED REACTIONS OF TRITIUM WITH ACETYLENE AND ETHYLENE.** Louis Kaplan (Argonne National Lab., Lemont, Ill.). *J. Am. Chem. Soc.* **76**, 1448-9(1954) Mar. 5.

The Hg-photosensitized reactions of C<sub>2</sub>H<sub>2</sub> and C<sub>2</sub>H<sub>4</sub> with a mixture of H isotopes were studied to determine the reaction kinetics of T. The relative T content of each of the products was determined and the probable mechanism discussed. (J.S.R.)

**URANIUM AND URANIUM COMPOUNDS**

2816

Argonne National Lab.

**PHASE EQUILIBRIA IN THE CONDENSED SYSTEM BROMINE TRIFLUORIDE-URANIUM HEXAFLUORIDE.** Jack Fischer and Richard C. Vogel. Oct. 8, 1953. Decl. with deletions Mar. 4, 1954. 15p. Contract W-31-109-eng-38. (AECD-3618; ANL-5130)

Investigation of the system bromine trifluoride-uranium hexafluoride has shown that it is a simple eutectic type. The solid phases, in equilibrium with saturated solutions, are the pure components. The system exhibits positive deviation from ideality. (auth)

2817

Argonne National Lab.

**SOLID-LIQUID PHASE EQUILIBRIA IN THE CONDENSED SYSTEM BROMINE-URANIUM HEXAFLUORIDE.** Jack Fischer and Richard C. Vogel. Oct. 20, 1953. Decl. with deletions Mar. 4, 1954. 6p. Contract W-31-109-Eng-38. (AECD-3619; ANL-5131)

Investigation of the system bromine-uranium hexafluoride has shown that it is a simple eutectic type. The solid phases are the pure components. The system exhibits positive deviation from ideality. (auth)

2818

**SIMPLE PREPARATION OF URANIUM OXYBROMIDE, URANIUM TETRABROMIDE, AND ANHYDROUS URANYL BROMIDE. EXISTENCE OF URANIUM PENTABROMIDE.** Jacques Prigent. *Compt. rend.* **238**, 102-4(1954) Jan. 4. (In French)

The oxybromide UOBr<sub>2</sub> passes directly to UOBr<sub>2</sub> at 300°C. Oxidation of UOBr<sub>2</sub> at 150°C results in UO<sub>2</sub>Br<sub>2</sub>. The reaction of CBr<sub>4</sub> and UOBr<sub>2</sub> at 175°C produces UBr<sub>4</sub>. The reaction of UO<sub>3</sub> with CBr<sub>4</sub> in a sealed tube appears to produce a U pentabromide, the exact composition of which has not been determined. (J.S.R.)

2819

**RECENT STUDIES ON IRON METEORITES. V. IMPROVED METHODS FOR THE ISOLATION OF URANIUM AND THORIUM FROM METEORITES.** J. C. Dalton and S. J. Tomson (Univ. of Durham, England). *Geochim. et Cosmochim. Acta* **5**, 74-80(1954) Feb. (In English)

A method is described for the separation of 10<sup>-8</sup> g quantities of thorium from solutions of iron meteorites, using



1-(*o*-arsono-phenyl-azo)-2-naphthol-3 : 6-disulfonic acid as a precipitant and zirconium as a carrier: uranium present has been shown to remain quantitatively in solution. Two methods are described for the recovery of uranium, in a sufficiently pure state for fluorimetry: these are solvent extraction and paper chromatography. A  $U^{233}$  tracer technique, combined with fluorimetry, has allowed reliable estimates to be made of meteoritic uranium. (auth)

2820

THE INFLUENCE OF URANYL AND THORIUM SALTS ON THE MISCIBILITY OF PHENOL AND WATER. S. T. Bowden and J. H. Purnell (Tatem Labs., University College, Cardiff, Wales). *J. Chem. Soc.*, 535-8(1954) Feb.

The critical solution temperature (C.S.T.) of phenol and water is depressed by uranyl acetate but raised by uranyl nitrate or sulfate and by Th nitrate or sulfate. At certain concentrations precipitation of a basic sulfate occurs in the systems containing thorium sulfate. For the other systems a logarithmic relation exists between the concentration of the salt and the depression or elevation of the C.S.T. The depression constant is 0.96 and the elevation constant is 0.86, which is identical with that found for systems containing salts of the light metals. In the lyotropic series representing the influence of ions on the C.S.T. of phenol and water,  $UO_2^{2+}$  lies between  $Be^{2+}$  and  $Pb^{2+}$ , while  $Th^{4+}$  falls between  $K^+$  and  $NH_4^+$ . (auth)

2821

DETERMINATION OF ACTIVITY COEFFICIENTS BY ULTRACENTRIFUGATION. ULTRACENTRIFUGATION OF URANYL FLUORIDE SOLUTIONS. James S. Johnson, Kurt A. Kraus, and T. Fraser Young (Oak Ridge National Lab., Tenn.). *J. Am. Chem. Soc.* 75, 1436-43(1954) Mar. 5.

Equilibrium ultracentrifugation of two-component systems is discussed from the point of view of determination of stoichiometric activity coefficients. Ultracentrifugation of cadmium iodide solutions was found to yield activity coefficients which were in satisfactory agreement with those in the literature. By ultracentrifugation, activity coefficients of  $UO_2F_2$  in aqueous solution were obtained which were similar to those found by freezing point depressions, thus supporting the earlier hypothesis of a monomer-dimer equilibrium. The dimerization constant appears to increase slightly with temperature, indicating a small and positive heat of dimerization. Ultracentrifugation of  $UO_2F_2$  in KF solutions indicates that excess fluoride ions increase the stability of the dimer considerably. (auth)

## WASTE DISPOSAL

2822

Lewis Van Carpenter Sanitary Engineering Research Lab., New York Univ.  
REMOVAL OF RADIOACTIVITY FROM LAUNDRY WASTES BY TRICKLING FILTERS. PROGRESS REPORT FROM SEPTEMBER 1, 1952 TO NOVEMBER 30, 1953. William E. Dobbins, Gail P. Edwards, Richard Ehrenreich, and Frederic A. Friedman. Dec. 1953. 34p. Contract AT-30-1-1246. (NYO-4567)

A radioactive laundry waste containing mixed fission products was treated continuously on single and two-stage trickling filters. The results indicate that about 90% of the gross activity can be removed at organic loading of 250 pounds BOD per acre foot day. The percentage removal decreases with increase in loading. Sludge was produced at a rate of about 0.3 pounds dry solids per pound BOD removed. The activity level reached by the sludge is shown to be essentially independent of loading rate but dependent on the activity level of the waste. (auth)

## ENGINEERING

\*2823

Polytechnic Inst. of Brooklyn  
DEFORMATIONS AND STRESSES IN CIRCULAR CYLINDRICAL SHELLS CAUSED BY PIPE ATTACHMENT. PART 6. DERIVATION OF GENERALIZED DONNELL-TYPE EQUATIONS FOR CIRCULAR CYLINDRICAL SHELLS WITH APPLICATION TO SHELLS WITH LINE LOADS ALONG GENERATRICES. Joseph Kempner. June 1953. 37p. Contract W-31-109-eng-52, Subcontract K-130 to Knolls Atomic Power Lab. (KAPL-926)

Mathematical equations for deformations and stresses in a cylindrical shell caused by pipe attachments are derived. The equations are solved for cases where the thin cylindrical shell is subjected to surface and edge loads. (For preceding report in series see KAPL-925.) (J.A.G.)

\*2824

Oak Ridge National Lab.  
SODIUM PLUMBING. A REVIEW OF THE UNCLASSIFIED RESEARCH AND TECHNOLOGY INVOLVING SODIUM AT THE OAK RIDGE NATIONAL LABORATORY. William B. Cottrell and Leland A. Mann. Aug. 14, 1953. 82p. Contract W-7405-eng-26. (ORNL-1688)

The research data and the development experience relevant to sodium obtained during the period 1950 to 1953 at the Oak Ridge National Lab. are summarized. Methods for testing the corrosion resistance of structural metals in sodium and the results of such tests are presented. The developmental work that has been done on the various components of sodium systems is described, and the relative merits of commercially available components are discussed. Cleaning, assembly, leak testing, and operating techniques and precautions are given. (auth)

## HEAT TRANSFER AND FLUID FLOW

2825

Ames Lab.  
TEMPERATURE DISTRIBUTION IN A METAL CYLINDER CONTAINING A HEAT SOURCE. Leon Pletke and Glenn Murphy. Aug. 1953. 26p. Contract W-7405-eng-82. (ISC-428)

A method for finding the temperature distribution in a metal cylinder containing a heat source distributed in any manner throughout the cylinder is reported. Specific solutions are given for cylinders with  $L/D$  ratios of 1, 2, 3, and  $\infty$ . The solution was developed by writing the general partial differential equation in the form of a difference equation containing a term proportional to the heat production. Solutions were obtained for the difference equation by modifying the known solution for a similar equation containing one less term. This approach was convenient as it eliminated the necessity of a solution by successive approximations. The results are not given directly in terms of temperature but are expressed in terms of a coefficient,  $\bar{n}$ . The temperature is equal to  $t + C'(\bar{n})$ . The term  $C'$  is equal to  $(16a^2/\pi^2)(B/k)$ , where  $a$  is the radius of the cylinder,  $B$  the heat production term per unit volume, and  $k$  the thermal conductivity. The expression of the results in terms of  $\bar{n}$  gives a general solution to the four cases. To obtain a specific numerical solution where the values of  $a$ ,  $B$ , and  $k$  are known, it is necessary to substitute them into  $C'$  and then multiply by  $\bar{n}$ . The actual temperature at a point is then equal to the surface temperature  $+C'(\bar{n})$ . The curves presented are general for the  $L/D$  ratios indicated and may be used with any variation of heat production and thermal conductivity throughout the cylinder. (auth)



2826

A CONTRIBUTION TO THE KINETIC THEORY OF HEAT CONDUCTION IN CRYSTALS. (Zur Kinetischen Theorie Der Wärmeleitung In Kristallen). R. Peierls. Translated from *Ann. Physik* 5, 1055-1101(1929). 66p. (AEC-tr-1849)

The mechanism of thermal conduction in the crystal lattice was investigated. The condition for the occurrence of a finite thermal conductivity proved to be identical with the condition for the existence of an H-theorem. This condition is satisfied for a three-dimensional lattice, and the property of the dispersion law responsible for this was determined. This mechanism proved to be considerably more complicated than appeared to be the case from Debye's first formulations. Debye's result on the temperature dependence at high temperatures could, however, be verified. On the other hand, when the atomistic structure was disregarded, an infinite thermal conductivity resulted, and, for the case of a linear chain of atoms, which is also devoid of physical meaning, proportionality to  $1/T^2$  resulted. For low temperatures an exponential drop in the thermal resistance resulted. In consequence of the lattice distortions, however, a term proportional to  $T$  may be superimposed on this drop. (auth)

2827

HEAT TRANSFER MEASUREMENTS AT SODIUM-STAINLESS STEEL INTERFACE. James W. Moyer and William A. Riemen (Knolls Atomic Power Lab., Schenectady, N. Y.). *J. Appl. Phys.* 25, 400-2(1954) Mar.

Experiments to measure the heat-transfer coefficient at a Na-type-347 stainless steel interface are described. The temperature range is 100 to 500°C. It is concluded that wetting does not play a significant role in the heat transfer. (auth)

2828

AN EXPERIMENTAL INVESTIGATION OF THE HEAT TRANSFER TO TURBULENTLY FLOWING PRESSURIZED AIR. A. W. Marris (University College Auckland, New Zealand). *Can. J. Phys.* 32, 190-200 (1954) Feb.

Employing a counter-flow figure-of-eight heat exchanger, direct measurements are made of the Nusselt modulus for radial heat transfer to air pressurized up to 20 atmospheres for Reynolds numbers up to  $1.20 \times 10^5$ . For each heat transfer determination a simultaneous friction factor measurement is made and it is found that the latter is independent of heat transfer. Results in reasonable agreement with the momentum transfer theory are obtained for Reynolds numbers less than  $0.75 \times 10^5$ , provided the ratio of the eddy diffusivities for heat and momentum is taken as unity. For such values of the Reynolds number, the same value of the heat transfer coefficient was obtained irrespective of whether the Reynolds number was obtained by having high pressure (density) and low velocity, or high velocity and low pressure. For higher values of the Reynolds number, however, the value of the heat transfer coefficient appeared to become dependent on the over-all heat transfer rate. (auth)

## MINERALOGY, METALLURGY, AND CERAMICS

### CERAMICS AND REFRACTORIES

2829

Lewis Flight Propulsion Lab., NACA  
INVESTIGATION OF A CHROMIUM PLUS ALUMINUM  
OXIDE METAL-CERAMIC BODY FOR POSSIBLE GAS

TURBINE BLADE APPLICATION. Charles A. Hoffman. Nov. 16, 1953. 12p. (NACA-RM-E53G07)

A metal-ceramic composition containing approximately 80 percent chromium plus 20 percent aluminum oxide ( $Al_2O_3$ ) by weight has been investigated for possible gas-turbine blade use. The results of modulus-of-rupture, thermal-shock, and blade-performance studies indicate that this material may have adequate thermal-shock resistance; however, the strength for this application appears marginal. (auth)

\*2830

Massachusetts Inst. of Tech.  
STUDY OF METAL-CERAMIC INTERACTIONS AT  
ELEVATED TEMPERATURES. QUARTERLY PROGRESS  
REPORT FOR THE PERIOD ENDING JANUARY 1, 1954.  
F. H. Norton, W. D. Kingery, et al. Jan. 1, 1954. 6p.  
Contract AT(30-1)-1192. (NYO-6292)

Surface tension measurements of  $P_2O_5$  have been undertaken by a pendant drop method. Various improvements in the equipment for measuring surface tension and contact angles by the sessile drop technique have been completed. Improvements in techniques and control of the system have led to an increased mean value for surface tension determinations, but the variation between supposedly pure samples is not satisfactory, as yet. Further modifications will be investigated. (For preceding period see NYO-6291.) (auth)

2831

Royal Aircraft Establishment, Farnborough, Hants  
(England)

THE IMPROVEMENT OF CERAMICS FOR USE IN HEAT  
ENGINES. F. J. Bradshaw. Oct. 1949. 8p. (RAE-TN-  
MET-111)

2832

Armour Research Foundation  
INVESTIGATION OF REFRACTORIES SUITABLE FOR  
MELTING TITANIUM AND ITS ALLOYS. Marvin Eisenberg  
and James Stavrolakis. July 1953. 29p. Contract AF-33  
(038)-23280. (WADC-TR-53-91; AD-6939)

Theoretical analysis of the published data pertaining to simple and complex fluorides suggested that it would be possible to produce certain fluoride and oxyfluoride complexes with melting points high enough to render them infusible at the temperature of molten titanium. Because of their potentially high chemical stability and the noncontaminating nature of the products of reaction between fluorides and titanium, fluorides seem particularly desirable as possible container materials for molten titanium. Attempts were made to prepare several synthetic oxyfluoride minerals, as well as a number of new oxyfluoride compounds. Though it was possible to produce highly refractory fluoride ceramics, success was not attained in producing the exact compound desired. Nor was the product completely stable within the required temperature range. An analysis of the results suggests that the optimum fabrication technique was not achieved. Under the handicap of pronounced instability, a number of the complex fluoride refractories produced were nevertheless superior to zirconia in resistance to molten titanium. However, a product suitable for industrial application has not yet been produced. (auth)

2833

THE ZIRCONIA-TITANIA SYSTEM. Frank H. Brown, Jr.  
and Pol Duwez (California Inst. of Tech., Pasadena). *J.  
Am. Ceram. Soc.* 37, 129-32(1954) Mar.

A phase diagram for the zirconia-titania system is proposed, based on the existence of a hitherto unreported compound,  $ZrTiO_4$ . Thermal-expansion and x-ray-diffrac-



tion experiments were performed on three series of specimens heated at 980, 1370, and 1760°C, respectively. (auth)

2834

FUNDAMENTAL STUDY AND EQUIPMENT FOR SINTERING AND TESTING OF CERMET BODIES. VI. FABRICATION, TESTING, AND PROPERTIES OF 72 CHROMIUM-28 ALUMINA CERMETS. Thomas S. Shevlin (Ohio State Univ., Columbus). *J. Am. Ceram. Soc.* 37, 140-5(1954) Mar.

Physical properties, including firing shrinkage, density, modulus of rupture from 75 to 2400°F, stress-rupture life in cross bending and in tension at 1800 and 2000°F, modulus of elasticity, tensile strength from 75 to 2000°F, comparative impact resistance, oxidation resistance, thermal expansion, and thermal-shock resistance, for the composition 28% alumina-72% chromium combine to indicate the potential value of this material in high-stress applications at elevated temperatures where severe thermal shock may be encountered. While the thermal-shock resistance is much better than that possessed by the low-chromium high-alumina bodies, the mechanical properties at elevated temperatures do not appear to suffer as a result of the highly continuous metal phase in the more recently developed body. (auth)

## CORROSION

2835

Naval Research Lab.

VOLATILE RUST INHIBITORS. Hayward R. Baker. Mar. 10, 1954. 23p. (NRL-4319)

Volatile products highly effective in the inhibition of rusting have been found in a wide variety of organic amines and acids and in the reaction products of amine with acids, the latter being particularly effective. Varying degrees of protection of ferrous surfaces can be expected from suitable members of the following classes of compounds: aliphatic or aromatic acids; primary, secondary, and tertiary amines; amine salts of weak inorganic acids; amine-organic acid complexes with organic acids; hydroxy-substituted aromatic acids and acid anhydrides; miscellaneous compounds such as nitromethane to nitropropane, morpholine, camphor, carbamides, and ammonium hydroxide; and any combination of compounds which on reaction yields any of the compounds mentioned in the series above. The association complexes formed by amines with weak acids hydrolyze or dissociate extensively to give volatile products capable of adsorbing on the surface to be protected. Inhibition is usually most effective in systems held at a pH between 7.5 and 8.5 and at a temperature that allows adequate vaporization of the inhibiting compound. Proper sealing against convective or diffusional loss of the inhibitor is essential. Detrimental effects due to humidity are minimized when these inhibitors are used in conjunction with silica gels. Because of possible corrosive injury by the vapor-phase rust inhibitor, certain nonferrous metals, such as cadmium and zinc, require special protection in the form of a plastic or waxlike spray that is impervious to the rust-inhibitor vapors. Volatile rust inhibitors have simplified the packaging, storage, and shipment of military equipment and replacement parts and have permitted immediate use of the packaged items without the tedious procedures normally associated with the removal of oil or grease preservatives before placing either stored or packaged equipment into service. Steel surfaces may be protected from rusting by simply wrapping the steel part with paper impregnated with the inhibitor crystals or by using inhibitor-coated paper as a liner for cartons or packages. Because of the economy and simplicity of these compounds and the techniques of their use, they are finding wide acceptance in military and industrial packaging procedures. (auth)

2836

## STABILITY OF REFRACTORIES IN LIQUID METALS.

E. L. Reed (North American Aviation, Inc., Downey, Calif.). *J. Am. Ceram. Soc.* 37, 146-53(1954) Mar.

Present technological developments are making more extensive use of liquid metals as heat transfer agents. Their stable and relatively noncorrosive character makes them especially adaptable for high-temperature applications. The compatibility of various liquid metals with refractories has been investigated in the past over a temperature range up to several hundred degrees centigrade. To extend this information to much higher temperatures, corrosion experiments were carried out utilizing liquid sodium, tin, and bismuth. Tests were conducted in the range 800 to 1500°C using molybdenum, tantalum, tungsten, graphite, alumina, zirconia, and other materials. The experimental apparatus and procedures employed in conducting both static and dynamic tests are described, and significant results are summarized. (auth)

## GEOLOGY AND MINERALOGY

2837

Wisconsin Univ.

NEW METHODS FOR URANIUM EXPLORATION AND RECOVERY FROM LOW GRADE ORES. RESEARCH PROGRESS REPORT [FOR] JANUARY 1, 1953 TO DECEMBER 31, 1953. 16p. Contract AT(11-1)-178. (AECU-2828)

The thermoluminescence of crystals, the storage of energy in minerals, and the relation between radioactivity and volcanism are discussed. The analysis of traces of uranium and thorium has been studied, and a large number of analyses have been made on rocks and waters, clays and vegetation. Particular attention has been given to the determination of the uranium content of obsidians, ashes, lava, bentonites and other materials of volcanic origin. Laboratory and field tests have been made on the practicality of extracting uranium from low grade ores with mobile equipment placed on trucks. (J.E.D.)

2838

Commissariat à l'Énergie Atomique (France)  
COMPOSITION CHIMIQUE ET AGE GEOLOGIQUE DE  
PECHBLENDES FRANCAISES ET DE L'URANINITE DE  
COTE D'IVOIRE. [Chemical Composition and Geological  
Age of French Pitchblende and Uraninite of the Ivory  
Coast]. [J.] Chervet, [C.] Guillemin, — Hemery, and  
[Paul] Pellas. Nov. 1953. 16p. (CEA-236)

Pitchblende from LaCrouzille, Bauzot, and Bigay and uraninites from the Ivory Coast of Africa were analyzed, and the geological age was determined. The step-by-step chemical procedure of the analysis is given, and the results are tabulated. The geological age of the pitchblende of LaCrouzille was calculated to be  $105 \pm 5$  million years in the first approximation, that of Bauzot, 135 million years, that of Bigay, 205 to 207 million years, and the uraninite of the Ivory Coast, either 1780 million years, or 1935 million years according to the logarithmic formula. (J.S.R.)

2839

Department of Mines and Technical Surveys. Mines Branch (Canada)

RADIOACTIVITY DIVISION GENERAL PROGRESS REPORT [FOR] OCTOBER-DECEMBER 1953. Jan. 28, 1954. 19p. (GPR-4/53)

The status of the work on ore dressing and extractive metallurgy, determination of U and F, tracer experiments and radiation detection instruments is briefly outlined. No technical data are reported. (J.E.D.)

\*2840

Health and Safety Lab., New York Operations Office, AEC  
MATHEMATICAL EVALUATION OF AIRBORNE RADIO-



LOGICAL SURVEY DATA. Ole Pedersen. Feb. 23, 1954. 9p. (NYO-4577)

Equations for the evaluation of radiation levels encountered in airborne radiological surveys, in terms of an isolated circular source of finite radius and uniform surface radioactivity on the earth's surface, and an expression for the surface activity of a cylindrical body of homogeneous radioactive material are derived. (auth)

2841

Tennessee Univ.

AN INVESTIGATION OF THE CHATTANOOGA BLACK SHALE OF TENNESSEE AS A SOURCE OF URANIUM. PROGRESS REPORT [FOR] JANUARY 1, 1953 TO JUNE 30, 1953. Paris B. Stockdale. 27p. Contract AT-(40-1)-1337. (ORO-106)

Detailed field studies have been confined mainly to Cannon, DeKalb, White, Smith, Putnam, Jackson, and Clay Counties, Tennessee. To date over 200 stratigraphic sections have been studied in the field in the search for all conceivable data bearing upon the stratigraphic conditions and their many implications. As of June 1, 1953, some 525 samples for uranium analysis have been collected at scattered localities and throughout different horizons of the Chattanooga shale. In addition, 60 samples from drill cores taken from the Youngs Bend area in DeKalb County, have been prepared for the Chemistry Laboratory. Fifty samples, collected from widely-spaced outcrops, have been sent to the U. S. Bureau of Mines oil shale experiment laboratory at Rifle, Colorado, for oil assays. In addition, miscellaneous special samples have been collected for microscopic examination and laboratory study. Several have been sent to Thomas F. Bates at Pennsylvania State Univ. for mineralogical study. Although some improvements have been made in sampling techniques, it is still the consensus of opinion that truly valid samples of fresh rock can best come from drill cores. (J.E.D.)

2842

Grand Junction Operations Office, AEC

PRELIMINARY REPORT ON URANIUM MINERALIZATION IN THE DAKOTA SANDSTONE ZUNI UPLIFT, NEW MEXICO. Arthur Mirsky. July 1953. 21p. (RME-47)

Uranium was discovered in the Dakota sandstone of the Zuni uplift, New Mexico. A study of the uranium occurrences in six mines led to the following conclusions: the uranium is closely associated with carbonaceous material and iron and occurs within or marginal to paleostream channels; five of the deposits are in sandstone containing carbonaceous material and the sixth is in a carbonaceous shale; cross-stratification, adjacent mudstone, and perhaps joints are factors determining the size and elongation of ore bodies. It is believed that the Dakota sandstone was deposited marginal to a sea with interbedded lagoonal, continental, and off-shore deposits suggesting a fluctuating shoreline. The presence of paleostream channels and their characteristics suggests a braided river system entering a lagoonal area. Suggestions are made for further studies concerning uranium mineralization in the Dakota sandstone. (auth)

2843

[Pennsylvania State Univ.]

AN INVESTIGATION INTO THE APPLICATION OF QUANTITATIVE ANALYSIS OF SEDIMENTS IN THE EXPLORATION FOR URANIUM ORE. PART 1. PROGRESS AND ACCOUNT FROM JULY 1, 1953 TO JUNE 30, 1954. J. C. Griffiths. 4p. Contract AT-(30-1)-1362. (RME-3088)

Activities connected with collection of quantitative data from the well cores and other samples from the Colorado Plateau are outlined. No data are included. (J.E.D.)

2844

RECONNAISSANCE FOR RADIOACTIVE DEPOSITS IN EASTERN INTERIOR ALASKA, 1946. Helmuth Wedow, Jr. and P. L. Killeen. Geological Survey Circular No. 331, 1954. 36p.

The techniques used in this survey consisted of the direct testing of outcrops for radioactivity with a portable survey meter and the collection of rock samples and placer concentrates for equivalent U analysis in the laboratory. No further information on the source of the few concentrates of higher radioactivity known previously was obtained, but a few new sites of radioactivity were found. Data for all sites, favorable or unfavorable, are presented. Lode deposits, consisting primarily of quartz veins containing gold and metallic sulfides, contain only as much as 0.005% equivalent U. Graphitic schists and black shales contain a maximum of 0.004% equivalent U; other types of schist contain only as much as 0.003% equivalent U. Tests of granitic and mafic igneous rocks indicate maxima of 0.006 and 0.005% equivalent U, respectively. Concentrates from placer deposits locally contain as much as 0.066% equivalent U. The slight radioactivity of the igneous rocks appears to be due to traces of U and Th in such accessory minerals as zircon and allanite. The slightly higher radioactivity of the placer samples at some localities is probably due to the natural concentration of the radioactive zircon and allanite. At a few localities, monazite has been found in the placers and probably also contributes to the radioactivity of the concentrates. Its bedrock occurrence is doubtless also as an accessory mineral in the granitic rocks. A field search failed to locate a reported occurrence of float from pitchblende veins in the Grant Creek Area north of the Yukon River about 30 miles west of Tanana in eastern interior Alaska. It is believed that fragments of black hematite were mistaken for pitchblende. (A.G.W.)

METALS AND METALLURGY

2845

Armour Research Foundation

PHASE RELATIONSHIPS IN MAGNESIUM-LITHIUM-ALUMINUM ALLOYS. SUMMARY REPORT [FOR] JULY 31, 1952-APRIL 30, 1953. D. W. Levinson and D. J. McPherson. July 22, 1953. 68p. Contract DA-11-022-ORD-906. (AD-16567)

Partial isothermal sections have been determined for the system Mg-Li-Al at 400, 300, 200, and 100°C by the methods of x-ray diffraction and metallographic analysis. Of 2 ternary intermediate phases previously reported, the existence of MgLiAl<sub>2</sub> was verified, and the existence of MgLi<sub>2</sub>Al as an equilibrium phase in this system is denied. MgLiAl<sub>2</sub> is cubic with parameter  $a = 20.2$  Å. Two vertical sections of interest have been constructed and both indicate the following sequence of phases in the alloy Mg-12.5 Li-10 Al.

Above 320°C	$\beta$
Between 320 and 240°C	$\beta + \text{AlLi}$
Below 240°C	$\alpha\text{-Mg} + \beta + \text{AlLi}$

Experimental methods and results of the investigation are fully discussed. (auth)

\*2846

Ames Lab.

CONSTITUTION DIAGRAM OF THE ANTIMONY-ZIRCONIUM ALLOY SYSTEM. R. F. Russi, Jr. and H. A. Wilhelm. Aug. 1951. Decl. with deletions Jan. 18, 1954. 42p. Contract W-7405-eng-82. (AECD-3610; ISC-204)

Antimony-zirconium alloys were prepared by diluting a master alloy of 23.6 wt. % antimony with magnesium-free sponge zirconium. The master alloy was made by diffusing analytical grade antimony into sponge zirconium in a sealed



stainless steel container at a temperature of about 825°C. These alloys were studied by microscopic examination of slow-cooled and quenched specimens. Thermal analysis and fusion temperatures as well as x-ray and hardness data were obtained. The addition of antimony to zirconium was found to bring about a peritectoid transformation, raising the solid  $\alpha$ -to- $\beta$  transformation for Bureau of Mines sponge zirconium from about 925 to approximately 980°C. The  $\beta$ -zirconium solid solution extends to 14 wt. % antimony at the eutectic temperature of 1430°C, and this drops off to about 2% at the peritectoid temperature. Antimony is soluble to about 2.5 wt. % antimony in  $\alpha$  zirconium from room temperature to the solid transformation. A eutectic was located at about 22% antimony. A compound which is reactive with water and atmospheric moisture was identified as  $Zr_2Sb$ . Antimony was found to harden zirconium in all cases, making increasingly brittle alloys as the compound was approached. (auth)

\*2847

Minerals Research Lab., Inst. of Engineering Research, Univ. of Calif., Berkeley  
INFLUENCE OF SUBSTRUCTURE ON THE SHAPE OF THE CREEP CURVE. T. H. Hazlett, R. D. Hansen, and E. R. Parker. Mar. 1954. 23p. Contract AT-11-1-Gen-10, Technical Report No. 13. (AECU-2827)

The shape of the creep curve for a given material may be changed drastically from continuously decreasing to continuously increasing creep rate by first subjecting the specimens to a prestrain and recovery treatment which induces a stable substructure in the material. The creep resistance of pure nickel and solid solution nickel alloys is vastly increased by the prestrain and recovery treatment prior to creep testing. The amount of substructure present at the beginning of a creep test is not the only factor that determines the shape of the creep curve. (auth)

2848

Ames Lab.  
MASS SPECTROMETRIC DETERMINATION OF LATENT HEATS OF METALS. Robert G. Johnson, D. E. Hudson, and F. H. Spedding. Dec. 1952. 107p. Contract W-7405-eng-82. (ISC-293)

A modification of the Knudsen method of determining vapor pressures was made. The modified method gave heat of vaporization measurements and melting point measurements for certain metals of low volatility. The technique which was developed made use of a 60° Nier-type mass spectrometer with a hot tungsten filament as the ionizing mechanism. Atoms from a Knudsen effusion vessel were allowed to fall upon a hot, clean filament and evaporate. A certain fraction of the atoms became ionized in the evaporation process, and this fraction constituted the ion beam in the mass spectrometer. The ion beam was directly proportional to the vapor pressure in the effusion vessel since the geometry of the system and the ionizing efficiency of the filament were maintained constant. Latent-heat values were obtained utilizing the fact that only a quantity directly proportional to the vapor pressure need be known. The latent heats of vaporization of aluminum, praseodymium, and neodymium were measured from 900 to 1200°C. The heat of vaporization of aluminum was found to be  $80.02 \pm 0.39$  kcal/mole at 1059°C. In the work on praseodymium it was possible to obtain heat of vaporization values in agreement with the value found earlier by Daane using the Knudsen method. However, inconsistencies between the data obtained from different samples of praseodymium and from the same samples with different amounts of heating in the effusion crucible remain unexplained. The neodymium data also exhibited unexplained variations, but

they were of a much lesser extent. The heat of vaporization of neodymium under the usual Knudsen conditions was found to be  $70.6 \pm 0.4$  kcal/mole at 1075°C. A phase transition in the condensed state was found in praseodymium at  $919 \pm 2.5^\circ\text{C}$ : A previously unreported transition was found in neodymium at  $1019 \pm 2.5^\circ\text{C}$ . On the basis of subsequent independent and as yet unpublished work done at this laboratory, it has been demonstrated conclusively that this corresponds to the melting point transition. A transition was also observed at a temperature of  $869 \pm 2.5^\circ\text{C}$ . Preliminary measurements were made of the first ionization potentials of praseodymium and neodymium using surface ionization theory and data obtained mass spectrometrically. Values of 5.4 and 5.5 v, respectively, were found. (auth)

\*2849

Ames Lab.  
ELECTROSTATIC ENERGY CALCULATIONS FOR SODIUM TUNGSTEN BRONZE ( $Na_xWO_3$ ). J. F. Smith. Feb. 15, 1954. 21p. Contract W-7405-eng-82. (ISC-460)

Recent measurements of the activation energy for diffusion of sodium in the metallic sodium-tungsten bronze,  $Na_{0.75}WO_3$ , gave a value of 51.8 kcal/mole. To determine whether ionic bonding could be responsible for this high activation energy, electrostatic energy calculations have been made. Calculated activation energies for sodium diffusion using a model with random sodium distribution do not agree well with the measured value, but this discrepancy may be caused by an ordering of the sodium atoms. Such ordering has been suggested to account for the anomalous resistivity at  $x = 0.75$ . Further calculations of the total electrostatic energy as a function of sodium concentration have been made on the basis of random sodium distribution, point charges of  $Na^+$ ,  $W^{+6}$ ,  $O^{-2}$ , and a uniform neutralizing charge of free electrons. These calculations indicate that cubic sodium-tungsten bronze should be unstable or metastable below  $x = 0.35$ . This calculated value of sodium concentration is in good agreement with the known phase transition occurring at a sodium concentration between  $x = 0.30$  and  $x = 0.38$ . (auth)

2850

Massachusetts Inst. of Tech.  
PERIODIC STATUS REPORT NO. 6 [FOR] NOVEMBER 1953-FEBRUARY 1954. 1. DEFORMATION STUDIES OF METALS AT ELEVATED TEMPERATURES. 2. THE IRON-CHROMIUM-NICKEL TERNARY SYSTEM. 3. EFFECT OF STRUCTURE AND COMPOSITION ON THE STRENGTH PROPERTIES OF STAINLESS STEEL. H. C. Chang, F. C. Monkman, Peter Price, and N. J. Grant. 5p. Contract N5-ori-07881. (NP-5100)

Comparison of the characteristics of grain-boundary migration during creep with those during static grain growth for Al and the status of the work on effect of structure and composition on strength properties of stainless steel are briefly reported. (For preceding period see NP-4942.) (J.E.D.)

2851

Laboratories for Research and Development, Franklin Inst.  
TECHNICAL PROGRESS REPORT. Mar. 1954. 7p. Contract AT-(30-1)-1484. (NYO-6108)

Some preliminary conclusions are presented on the comparison of absorption and sectioning techniques as a means of studying diffusion, a study of the effects of electroplating vs. evaporation as a means of applying the radioactive tracer element to the sample surfaces, and a study of the effects on the diffusion data of applying very large and very small amounts of radioactive tracer to the samples. Application of a replicating film to a surface and then etching the surface through the film are described. (J.E.D.)



2852

Massachusetts Inst. of Tech.

SOLID SOLUTIONS AND GRAIN BOUNDARIES. PROGRESS REPORT NO. 20. B. L. Averbach, M. Cohen, F. Herbstein, J. Hilliard, P. S. Rudman, and E. E. Underwood. Dec. 31, 1953. 3p. Contract AT(30-1)-1002, Scope 2. (NYO-7039)

Preliminary x-ray diffuse-scattering measurements have been made on Li-Mg and Co-Pt alloys. The measurements represent the first experimental data on the actual sizes of atoms in solid solutions. Measurements on precipitation kinetics in the Au-Ni system are briefly reported. (L.T.W.)

2853

Sylvania Electric Products, Inc.

STRESS-STRAIN CHARACTERISTICS AND SLIP BAND FORMATION IN METAL CRYSTALS. 1. INTRODUCTION AND EXPERIMENTAL TECHNIQUES. 2. THE EFFECT OF CRYSTAL ORIENTATION. F. D. Rosi. Feb. 8, 1954. 27p. Contract AT-30-1 GEN 367. (SEP-129)

A program was initiated to study the effects of crystal orientation, temperature of testing, alloying, and other parameters on the stress-strain characteristics and slip-band formation in several face-centered-cubic metals for the purpose of establishing a correlation between these two important manifestations of glide. The methods used for single crystal production and crystal surface preparation were described in detail, as well as methods of tensile testing which included discussion of a grip assembly for homogeneous extension. The plastic properties of extended silver and copper crystals of varying purity were studied as a function of crystal orientation in the early stages of flow. Variations in the gross shape of the shear stress-shear diagram and in the properties of critical shear stress and shear hardening coefficient were correlated with changes in slip band development. The phenomenon of work hardening is discussed in terms of existing dislocation theory. (auth)

2854

Armour Research Foundation

RECRYSTALLIZATION WELDING OF ALUMINUM AIR-CRAFT ALLOYS. Nickolas A. DeCecco and John M. Parks. Dec. 1953. 103p. Contract AF-18(600)-92. (WADC-TR-53-231)

Recrystallization is established as the mechanism for solid-phase welding. 2S, 24S, 52S, and 61S aluminum alloys were welded by pressing together two cleaned and cold-worked surfaces and heating to the recrystallization temperature. The shear strengths of the welded joints are equivalent to that of the annealed metal. The fundamental forces in operation when making a recrystallization-welded joint have been investigated and analyzed. The basic principles and techniques described are applicable to metals other than aluminum and aluminum-base alloys. (auth)

2855

Battelle Memorial Inst.

PRODUCTION OF SOUND DUCTILE JOINTS IN MOLYBDENUM. M. I. Jacobson, D. C. Martin, and C. B. Voldrich. Jan. 1954. 71p. Contract AF 33(616)-10. (WADC-TR-53-401)

Methods of welding and brazing molybdenum with the objective of producing sound ductile joints were investigated. The results of tungsten-arc welding tests showed that, although ductile weld metal could be produced, the welded joints were brittle transverse to the direction of welding because of recrystallization in the base metal. Several brazing methods were investigated, with induction brazing in an argon atmosphere appearing to be the most satisfactory from the standpoint of braze quality and practicability. Braze joints were tested at room temperature and at 1800°F. The brazing alloys that gave the best results at 1800°F were Inconel and Haynes Alloy 25, which produced joints with 100-

hour shear strengths of 5000 psi and 4500 psi, respectively. (auth)

2856

Armour Research Foundation

ELECTROPLATING ON TITANIUM. FINAL REPORT [FOR] SEPTEMBER 1, 1952-SEPTEMBER 30, 1953. Harold L. Schick. 13p. Contract DA-11-022-ORD-1045. (WAL-401/46-29)

Various methods for electrodepositing adherent metallic coatings on Ti were investigated. It was found that the best adherence was mechanical in nature and that the best possibility for a true metal-to-metal bond lies in the development of a process using an immersion technique. (For preceding period see NP-4210.) (J.E.D.)

2857

Battelle Memorial Inst.

THE WELDING CHARACTERISTICS OF SELECTED TITANIUM ALLOYS. INTERIM TECHNICAL REPORT. G. E. Faulkner, G. E. Martin, and C. B. Voldrich. Dec. 15, 1953. 36p. Contract DA-33-019-ORD-231. (WAL-401/97-28)

Tests were conducted on the base metals and welded joints consisted of base-metal tension tests and base-metal and weld-joint bend tests, notch-toughness tests, hardness studies, and microstructural examinations. Alpha-beta alloys containing aluminum appear to be promising for welding applications. The addition of limited amounts of aluminum to the alpha-beta alloys increased their tensile strength but did not lower their weld-joint properties appreciably (bend ductility and notch toughness). Several of these alloys had good weld-joint properties, and their tensile strengths ranged from 103,000 to 141,000 psi and could be varied by heat treatment. The weld-joint properties of the alpha-beta alloys appeared to depend primarily on the amount of beta-stabilizing elements in the alloys rather than on the choice of alloying element. The binary titanium-vanadium alloys tested appeared to produce consistently better weld-joint properties than any of the other alloys investigated. A metastable-beta titanium alloy containing 9.2% chromium and 8.5% vanadium produced ductile welds made with both single and multiple passes and had a tensile strength of 129,000 psi. Large 10-pound ingots of this alloy could not be forged. (For preceding report in series see WAL-401/97-27.) (auth)

2858

New York Univ. Coll. of Engineering

BETA PLASTICITY IN TITANIUM-BASE ALLOYS. INTERIM TECHNICAL REPORT NO. 2 [FOR JULY 31 TO OCTOBER 31, 1953]. P. Albert and I. Cadoff. Dec. 15, 1953. 24p. Contract DA-30-069-ORD-869. (WAL-401/147-18)

Experimental techniques were established for the conduct of the different projects comprising the plasticity investigation. These include techniques for the production of large beta crystals and for obtaining drawing textures and pole figures of cold deformed beta alloys. (For preceding period see WAL-401/147-13.) (auth)

2859

ORIGIN OF SPIRAL EUTECTIC STRUCTURES. R. L. Fullman and D. L. Wood (General Electric Research Lab., Schenectady, N. Y.). *Acta Met.* 2, 188-93 (1954) Mar. (In English)

Eutectic structures in which the two phases appear as intertwined spirals in cross section have been observed in zinc-magnesium and aluminum-thorium alloys. The spatial form of the eutectic structure in zinc-magnesium alloys is a spiral cone. A theory of the solidification conditions necessary for formation of this type structure is advanced based on a particular type of anisotropy in the difference in growth rates of the phases. (auth)



2860

INTERNAL FRICTION IN TITANIUM AND TITANIUM-OXYGEN ALLOYS. J. N. Pratt and W. J. Bratina (Univ. of Toronto, Canada) and B. Chalmers (Harvard Univ., Cambridge, Mass.). *Acta Met.* 2, 203-8(1954) Mar. (In English)

A low-frequency torsional pendulum technique has been used to study internal friction in alpha-titanium and in some titanium-oxygen alpha solid solutions containing up to 4.5 atomic per cent oxygen. Characteristic grain-boundary relaxation peaks are exhibited by the pure titanium and by the alloys; the respective heats of activation were found to be 46,000 cal/mole and 75,000 cal/mole. The introduction of oxygen results in the appearance of an additional relaxation peak at approximately 700°K; the mechanism involved is not established, but the associated heat of activation is estimated as 48,000 cal/mole. (auth)

2861

THE EFFECTS OF CERTAIN ALLOYING ELEMENTS ON THE ALLOTROPIC TRANSFORMATION IN TITANIUM. H. W. Worner (Univ. of Melbourne, Australia). *Acta Met.* 2, 310-12(1954) Mar. (In English)

Alloying elements with atomic sizes close to that of titanium are considered. The change in enthalpy ( $\Delta H$ ) which accompanies the transfer of 1 gram-atom of any given solute from  $\beta$ -phase to  $\alpha$  is used as an indication of the effect of that solute on the  $\alpha \rightleftharpoons \beta$  transformation. The estimation of values of  $\Delta H$  from phase boundaries is outlined. It is shown that the Brillouin zone characteristics of the allotropes of titanium are probably important in determining the influence of the elements discussed on the  $\alpha \rightleftharpoons \beta$  transformation. (auth)

2862

OXIDE GROWTH ON DIFFERENT CRYSTAL FACES OF ALUMINIUM. S. Basinska, J. J. Polling, and A. Charlesby (Atomic Energy Research Establishment, Harwell, Berks, England). *Acta Met.* 2, 313-17(1954) Mar. (In English)

The growth of oxide on different crystal faces of aluminum is studied. According to the theory of the oxidation of a metal proposed by Mott, metallic ions migrate from the metal surface to the oxide-air interface. These ions must first overcome the potential barrier at the metal-oxide interface, and if this is different on different crystal faces, then the oxide thickness will also be different. The oxide films were formed electrolytically, so that the potential difference across the oxide was known. The orientations of the crystals were found by goniometer measurements and x-ray-diffraction methods. The thickness of the oxide was obtained by a study of the interference colors shown by these thin films, the method being capable of showing a change in film thickness of about 40Å. Two known crystal faces were produced by etching techniques, and both etched and electropolished surfaces were studied. No significant variation in oxide thickness was observed on different crystal faces. (auth)

2863

WORK-SOFTENING IN ALUMINIUM CRYSTALS. R. J. Stokes and A. H. Cottrell (Univ. of Birmingham, England). *Acta Met.* 2, 341-2(1954) Mar. (In English)

Al crystals, work hardened at low temperatures, abruptly soften when the crystal is plastically strained at a high temperature instead of being rested there. This effect is described as work softening. (J.S.R.)

2864

ELECTRIC RESISTANCE AND TRANSPARENCY OF FILMS OF THE ALLOYS Mg-Sb, Mg-Bi, AND Mg-Sn. G. A. Kurov (Moscow Engineering Physics Inst.). *Doklady Akad.*

*Nauk S.S.S.R.* 94, 207-8 (1954) Jan. 11. (In Russian)

The resistivity of the alloys and their transparency to light for varying thicknesses are tabulated. (J.S.R.)

2865

DIFFUSION OF GOLD INTO COPPER. A. B. Martin, R. D. Johnson, and Frank Asaro (North American Aviation, Inc., Downey, Calif.). *J. Appl. Phys.* 25, 364-9(1954) Mar.

Radioactive tracer techniques have been utilized to measure the rate of diffusion of Au into polycrystalline Cu over the temperature range from 1000 to 375°C. These experiments have yielded the values  $Q = 44,900 \pm 1300$  cal/mole and  $D_0 = 0.10 \pm 0.06$  cm<sup>2</sup>/sec for the volume diffusion process in the temperature range from 1000 to 750°C. Diffusion measurements at 550 and 375°C indicated that the measured rates at these temperatures had been enhanced by grain-boundary diffusion. Considerable attention was directed toward the variation of the diffusion coefficient with (1) the purity of the Cu, (2) the grain size of the Cu, (3) the thickness of the plating, and (4) the time of anneal. Variations of these parameters showed no significant effect on the diffusion coefficient, with the exception of the time of anneal. The measured diffusion rate at 1000°C was observed to decrease with increasing time of anneal. (auth)

2866

MECHANISM OF CREEP DEFORMATION IN HIGH-PURITY ALUMINIUM AT HIGH TEMPERATURES. Hsing C. Chang and Nicholas J. Grant (Massachusetts Inst. of Tech., Cambridge). *J. Inst. Metals* 82, 229-35(1954) Feb.

Creep of very coarse-grained high-purity aluminum was studied at 400, 700, and 1100°F (205, 370, and 595°C) over a stress range from 50 to 1200 lb/in.<sup>2</sup>. Simultaneous observations and measurements of localized strains on polished specimen surfaces were made by means of a high-temperature microscope. The sequence of the development of various deformation modes, heavy slip bands, kink bands, and subgrains was followed. Slip is the fundamental mechanism of deformation for both single-crystal and polycrystalline materials even in high-temperature creep. Component creep curves (measured between two closely spaced markings) obtained across grain-boundary-affected slip bands show a periodic behavior, the significance of which is discussed. Subgrains are shown to be formed under conditions where slip development is restricted. Two types of subgrains, one caused by deformation bands and the other by kinking bands, are observed and discussed. (auth)

2867

AGEING CURVES AT 110°C. ON BINARY AND TERNARY ALUMINIUM-COPPER ALLOYS. H. K. Hardy (Fulmer Research Inst. Ltd., Stoke Poges, Bucks, England). *J. Inst. Metals* 82, 236-8(1954) Feb.

Binary Al alloys containing 2.5 to 4.5% copper gave two-stage hardness/aging-time curves separated by a flat plateau. The incubation values supported the conclusion that the reciprocal-rate curves take the form of two C-curves overlapping in the region 150 to 170°C. The inflected form of the peak-hardness/composition relationship was confirmed. The ternary alloys with 0.05% tin or indium gave weak indications of two-stage aging curves but reached their peak hardness after much shorter aging times. (auth)

2868

STRUCTURAL AGEING CHARACTERISTICS OF BINARY ALUMINIUM-COPPER ALLOYS. (Miss) J. M. Silcock, T. J. Heal, and H. K. Hardy (Fulmer Research Inst., Ltd., Stoke Poges, Bucks, England). *J. Inst. Metals*, 82, 239-48 (1954) Feb.

A systematic x-ray study has been made of the structures formed during the aging of aluminum-copper alloys over a wide range of supersaturation. The specimens examined



included single crystals taken from the polycrystalline hardness specimens used by Hardy when obtaining the aging curves of the alloys. The structures pass through the sequence: G. P. zones [1]  $\rightarrow$  G. P. zones [2] (Guinier's  $\theta''$ )  $\rightarrow \theta' \rightarrow \theta$ , and each of these may in turn be found as the initial decomposition product as the degree of supersaturation diminishes. G. P. zones [1] are responsible for the initial rise in hardness and do not change in size along the "flat plateaux" of the aging curves. The higher group of peak-hardness values is due chiefly to the presence of the G. P. [2] structure, although a small quantity of  $\theta'$  is also present. The lower group of peak-hardness values is attributable to a structure containing only the  $\theta'$  precipitate. The neat manner in which the x-ray structural data can be correlated with the aging curves must not obscure the fact that the preferred modes of formation and some of the structural details of the precipitates are still unknown. (auth)

2569

CHANGES OF DAMPING CAPACITY IN QUENCH-AGEING ALUMINIUM-RICH ALLOYS. K. M. Entwistle (Univ. of Manchester, England). *J. Inst. Metals* **82**, 249-63(1954) Feb.

Changes of damping capacity recorded during the aging of quenched Duralumin at constant temperatures up to 65°C reveal two distinct contributions to the vibrational energy loss. The second of these, which appears as a peak in the curve relating damping and aging time, has been investigated in detail. The time to reach peak damping was found to vary with aging temperature (T, °K.) as  $\exp(H/RT)$ , where H is 38,000 cal./mole. Further, the damping was established to be of anelastic origin, having a temperature-dependent relaxation time governed by a heat of activation of 13,500 cal./mole. Simpler, high-purity alloys, namely the binary alloys of aluminum with copper, manganese, or iron, and the ternary aluminum-magnesium-silicon, aluminum-copper-silicon, and aluminum-copper-magnesium alloys, showed neither of these effects, nor did commercial-purity alloys of aluminum-magnesium and aluminum-magnesium-silicon. The damping of a quaternary aluminum-copper-magnesium-silicon alloy rose to a peak during aging. This is considered to correspond to the second contribution observed in Duralumin, since the activation energies describing the temperature dependence of relaxation time (13,200 cal./mole) and the attainment of peak damping during aging (38,000 cal./mole) are in good agreement with the corresponding values for Duralumin. The marked difference between the two activation energies in both alloys is taken to mean that the factor governing the attainment of peak damping during aging is different from that responsible for the vibrational energy loss, but it is not possible at this stage to identify the precise mechanism by which the damping arises. (auth)

2177

SOME METALLOGRAPHIC OBSERVATIONS OF THE CREEP OF ALUMINIUM-COPPER ALLOYS. A. H. Sully and H. K. Hardy (Fulmer Research Inst., Ltd., Stoke Poges, Bucks, England). *J. Inst. Metals* **82**, 264-5(1954) Feb.

In aluminum-copper alloys containing 3 and 4% copper, creep at 190°C occurred preferentially in relatively narrow regions, depleted in solute, on either side of the grain boundary. Plastic flow accentuated the precipitation process in the material immediately adjacent to the grain boundary, thus widening the band of material with a low resistance to deformation. Shear displacement across boundaries favorably oriented to the applied stress was accompanied by the formation of fissures transverse to the stress direction. High-purity alloys showed the effects most prominently and

gave intercrystalline fractures. Normal-purity alloys possessed a much better creep-resistance but also gave intercrystalline failure when previously aged at 190°C. Normal-purity material aged at 300°C gave ductile fractures associated with longitudinal fissures in the necked region. The results point to the importance of grain-boundary stability in creep-resistant alloys. (auth)

2871

DIFFUSION OF ANTIMONY IN SILVER. E. Sonder, L. Slifkin, and C. T. Tomizuka (Univ. of Illinois, Urbana). *Phys. Rev.* **93**, 970-2(1954) Mar. 1.

The diffusion coefficient of antimony tracers in single crystals of pure silver has been measured as a function of temperature over the range 468-942°C. The relation  $D = D_0 \exp(-H/RT)$  was found to be obeyed with  $H = 38,320$  cal./mole and  $D_0 = 0.169$  cm<sup>2</sup>/sec. These values are in marked disagreement with those appearing in the literature. The data suggest, in addition, that any variation with temperature in  $D_0$  of the form  $D_0 = D_0' T^n$  is such that n probably lies in the range of 0 to +1/2. This implies that any temperature variation of H is probably less than 1 cal./mole deg. (auth)

2872

EFFECT OF SCREENING ON SOLUTE DIFFUSION IN METALS. David Lazarus (Univ. of Illinois, Urbana). *Phys. Rev.* **93**, 973-6(1954) Mar.

A simple atomistic theory of solute diffusion in metals for cases of negligible chemical concentration gradients is discussed. Calculations are made, using a Thomas-Fermi approximation, of the influence of the presence of impurity atoms on the Fermi electrons of the lattice. The results are applied to the case of diffusion of Sb in Ag, and indicate that the screening terms are sufficient to explain the magnitude and direction of the observed deviation from self-diffusion in Ag for a vacancy mechanism for diffusion. (auth)

2873

A STUDY OF BOEHMITE FORMATION ON ALUMINIUM SURFACES BY ELECTRON DIFFRACTION. R. K. Hart (Univ. of Cambridge, England). *Trans. Faraday Soc.* **50**, 269-73(1954) Mar.

The action of boiling distilled water on aluminum, including mechanically polished, electropolished, and anodized specimens, has been investigated by electron diffraction. The patterns correspond to boehmite,  $\gamma$ -AlO(OH). Oriented diffractions, obtained from specimens immersed for approximately 5 min, were attributed to (100) planes in the boehmite lattice being parallel to the specimen surface. Boehmite is probably produced by the reaction of hydroxyl ions with aluminum ions moving outwards from the metal; the reaction first occurs in the pores of the pre-existing oxide layer and later on the outer surface. An electron diffraction method for determination of film thickness on aluminum single crystals is described. (auth)

## PHYSICS

2874

Los Alamos Scientific Lab.  
APPLICATIONS OF HIGH EXPLOSIVES AND HIGH SPEED PHOTOGRAPHY TO PHYSICAL RESEARCH EXPERIMENTS. [F. J. Willig]. [nd] Decl. Jan. 18, 1954. 59p. Contract [W-7405-eng-36]. (AECD-3620)

The types of experiments conducted in connection with



fundamental research programs in the fields associated with the behavior of materials subjected to high-explosive shock are reported. The description of the photographic equipment involving the use of two types of camera is limited to those used in the experiments. The types of explosives used were a mixture of TNT and RDX, employed as a prime mover, PETN used primarily in the form of primacord and a mixture of TNT and inert salts, used as a prime mover in place of the TNT-RDX mixture when a lower detonation velocity or lower shock pressure is desired. (J.E.D.)

2875

Los Alamos Scientific Lab.

FAST JET ACTUATED SHOCK TUBES. [F. J. Willig]. [1952?] Decl. Feb. 2, 1954. 9p. Contract [W-7405-eng-36]. (AECU-3621)

A small glass shock tube partitioned at its center by means of a thin diaphragm is actuated by directing a fast jet into one end. In traversing the distance to the partition, a high pressure is generated which in turn imparts a high shock velocity to the region beyond. The entire process is highly self-luminous, hence may be recorded by means of a moving image slit camera operating at high speed. Hydrogen gas at a pressure of about one-third of an atmosphere is used in the first part of the tube while the pressure in the other part is maintained at a much lower value. If the latter region is highly evacuated, velocities in the neighborhood of  $10^4$  cm/sec have been observed. (auth)

2876

Sandia Corp.

EXTENSION OF THE SOMMERFELD DIFFRACTION THEORY TO WEDGES OF ARBITRARY ANGLE. Hugh E. DeWitt. [1952?]. 13p. Contract [AT(29-1)-789]. (AECU-2826)

The Sommerfeld wedge diffraction formula for pulses of arbitrary shape is given as the sum or difference of two series, each with  $m$  terms, where the external angle of the wedge is  $(n/m)\pi$ . In this paper the series are summed. This summation makes it possible to give a general diffraction formula which holds for wedges of all angles. The general formula is much easier to use than the series, when making numerical calculations of pressures resulting from sound-pulse diffraction. The properties of this formula are discussed. The integration is carried out for the case of a step-function pulse. (auth)

2877

Wisconsin Univ.

THE PRODUCTION OF DOUBLY CHARGED HELIUM IONS. John W. Bittner. [1953] 11p. Contract [AT-11-1-GEN-7]. (AECU-2829)

A 0.6- $\mu$ a beam of  $\text{He}^{++}$  ions has been produced and accelerated to 7.6 Mev in an electrostatic generator. The  $\text{He}^{++}$  ion source, contained in the high-voltage electrode of the generator, consists of a second small 400-kv electrostatic generator driven by the upper belt pulley of the main machine.  $\text{He}^+$  ions obtained from a low-voltage arc-type ion source in the dome of the small generator pass through a region of low-pressure gas to become doubly ionized before entering the main accelerating tube of the large generator. (auth)

\*2878

Livermore Research Lab., Calif. Research and Development Co.

DIFFUSION EQUATION FOR RADIOACTIVE SPECIES IN THIN-PLATE NUCLEAR REACTORS. L. M. Litz. Mar. 1954. 13p. Contract AT(11-1)-74. (LRL-97)

The concentration function was derived for radioactive atoms being produced by nuclear reactions in thin plates

and diffusing out of the plates into an essentially infinite medium. The radioactive decay was also taken into account. From this function, the equation for the accumulation of radioactivity in the surrounding medium was obtained. Curves are shown which evaluate the latter function for a range of the parameters involved to aid in calculating the extent of transfer of the radioactive isotopes into the adjacent medium. An example of such a numerical calculation is given. (auth)

2879

National Bureau of Standards

THRESHOLD FIELD PROPERTIES OF SOME SUPERCONDUCTORS. E. Maxwell and O. S. Lutes. Feb. 23, 1954. 25p. Contract CS-670-53-8. (NBS-3146)

Some refined measurements of the critical field curves for Sn, Tl, In, and Hg have been completed, and the results compared with the specific predictions of the Gorter-Casimir and the Koppe versions of the two-fluid model of superconductivity. Neither version is completely adequate, although each has points in its favor. The Koppe prediction of a universal critical field curve for all superconductors is not verified. The Gorter-Casimir  $\alpha$ -model has greater flexibility than the Koppe model and, although it is capable of giving a fair description of the critical field data, it is in some respects also inconsistent with the data. The isotope effect in Tl has been observed and is consistent with the half-power law. (auth)

2880

Duke Univ.

MEASUREMENTS WITH THE OXYGEN ELECTRODE AT HIGH TEMPERATURES. [FINAL REPORT]. Douglas G. Hill and Bernard Porter. Sept. 15, 1953. 83p. Contract AT-(40-1)-1526. (ORO-113)

An oxygen electrode was constructed for use in fused-salt media at high temperatures. By having the reaction at high temperatures and in nonaqueous media, it was hoped to make the oxygen electrode function as a half-cell whose reaction would be:  $\frac{1}{2} \text{O}_2 + 2e = \text{O}^{2-}$ . This electrode was used in measuring the EMF of formation of metallic oxides which were formed on the heavy metal surface. In general, the oxides formed were insoluble in the reaction medium. The oxygen electrode was prepared in the form of a Hildebrand type of gas electrode which was found to be convenient for the work involved and which responded quickly to changes at the electrode surface. Measurements were also made with an unshielded platinum wire showing that the Hildebrand form of the oxygen electrode came to equilibrium more quickly. Experimental measurements were made to show that the oxygen electrode responded to changes in the partial pressure of the oxygen gas used in the oxygen electrode. Previous experimenters had demonstrated that this electrode in fused salts was reversible to the oxide ion in the melt. Measurements were made in the several cells in a eutectic of lithium-potassium sulfate which contained calcium oxide. (auth)

2881

Evans Signal Lab., Signal Corps Engineering Labs.

X-RAY EMISSION FROM HIGH VOLTAGE HYDROGEN THYRATRONS. Bernard Reich and Sol Schneider. June 18, 1953. 19p. (SCEL-M-1518; AD-16243)

A study was begun to determine the radiation levels and characteristics of the x rays emitted from H thyatron types 1257, 5948/1754, and 5949/1907. Tests showed that for a peak voltage of 42 kv and at a distance of 1 ft the radiation intensity of the type 1257 was 1230 mr/hr. The radiation intensities of the other 2 tubes at 27.5 kv and a distance of 1 ft were both 30 mr/hr. External shielding was recommended during testing of thyatron type 1257. (ASTIA)



2882

Radiation Lab., Univ. of Calif., Berkeley  
PHYSICS DIVISION QUARTERLY REPORT [FOR] AUGUST,  
SEPTEMBER, OCTOBER 1953. Dec. 15, 1953. 51p.  
Contract W-7405-eng-48. (UCRL-2434)

The construction of a cloud chamber 8 ft  $\times$  4 ft  $\times$  5 in., for cosmic-ray air shower measurements is described. The chamber was used to determine the lateral structure of 3 showers in which the core lay within 60 to 90 cm from some point on the periphery of the chamber. Shower measurements showed good agreement with Molière distribution. Total p-p cross sections were remeasured at 340 and 245 Mev (lab), and the c.m. cross section was found to be  $24 \pm 2$  mb/ster, corresponding to  $\frac{d\sigma}{d\omega_{90^\circ}} = 3.8 \pm 0.3$  mb/ster. An experiment on the polarization of proton beams is described, where the beam is produced by a first-scattering process and detected by a second scattering. The data indicate that a polarization of greater than 60% was obtained by the experimental arrangement described. Differential n-p scattering cross sections were measured at 10 to 40° to a 90-Mev neutron beam. Preliminary results indicate that the cross section is a factor of 2 greater at 5° than at 18.5°. Internal beam deflector design and performance for the 60-in. cyclotron is described in detail. (For preceding period see UCRL-2340.) (K.S.)

2883

THE EFFECT OF LATTICE ANISOTROPY ON LOW-TEMPERATURE SPECIFIC HEAT. W. DeSorbo (General Electric Research Lab., Schenectady, N. Y.). *Acta Met.* 2, 274-83 (1954) Mar. (In English)

A general analysis has been made in terms of the Debye theory of most of the available low-temperature specific heat data of monatomic solids. The results of the analysis are compared among the various crystal structures including the highly anisotropic lattices. An attempt has also been made to apply for the purpose of general analysis the Tarasov quasi-empirical specific heat integrals to describe lattice anisotropy. The results of such an analysis are summarized for Se, Te, Hg, In, Zn, Cd, Sb, Sn (white), and Li (low-temperature phase). The comparison using this simple model shows that the anisotropy of mercury and indium is "similar" to that of tellurium and selenium and that the anisotropy of zinc and cadmium is "similar" to that of other "layer" structure elements. The relative number of "soft" and "hard" modes of vibration of these anisotropic lattices have been calculated using simple continuum models. A qualitative method is pointed out for distinguishing between monatomic isotropic lattices, polymeric "chain" lattices, and polymeric "layer" lattices from low-temperature specific heat data. (auth)

2884

ELECTRON AND PHOTOCURRENTS IN THIN FILMS OF  $ZrO_2$ . D. A. Vermilyea (General Electric Research Lab., Schenectady, N. Y.). *Acta Met.* 2, 346-8 (1954) Mar. (In English)

A mechanism proposed to account for the variation of the electron current through thin films of anodic  $ZrO_2$  was based on the assumption that there exists a symmetrical potential barrier which the electrons must surmount. It is shown, however, that the probability of tunneling through the barrier is greater than the probability of the electrons being thermally excited over the barrier. An alternate mechanism is proposed, based on the assumption that there are trapping centers for electrons in the film, the depth of which is lowered by the applied field. (J.S.R.)

2885

REPORTS FROM THE CONFERENCE OF THE SWEDISH NATIONAL COMMITTEE FOR PHYSICS IN 1952. Gudmund

Borelius and Erik Rudberg. *Arkiv Fysik* 7, 73-88(1954).

Short summaries of the papers presented at the conference of the Swedish National Committee for Physics in Stockholm, Sept., 1952 are given. The meeting coincided with the International Instruments and Measurements Conference and Exhibition, and speakers from each group participated in the sessions of the other. Most of the papers were concerned either with theoretical or nuclear physics directly, or bore an indirect relationship (e.g., measuring instruments and techniques). (L.M.T.)

2886

FAST NEGATIVE HYDROGEN IONS. A. Charles Whittier (McGill Univ., Montreal, Canada). *Can. J. Phys.* 32, 275-90(1954) Apr.

A proton beam was directed through H gas at low pressure, and magnetic analysis of the emergent beam showed that an appreciable fraction of the beam was transformed into negative H ions. After the beam had traversed a sufficient layer of gas, the ratio of negative H ions to protons reached an equilibrium value which was a maximum of 22.2% at 8.5 kev. The proton energy interval investigated extended from 4 to 70 kev. In this interval the electron loss cross section for negative H ions was measured and found to vary from  $6.3 \times 10^{-16}$  cm<sup>2</sup> at 4.2 kev to  $2.5 \times 10^{-16}$  cm<sup>2</sup> at 70.3 kev. The electron capture cross section for protons in H was measured over the same interval, and the results agreed substantially with those of other workers. The electron capture cross section for neutral atoms was also determined by combining present results for the negative ion loss cross section and for the equilibrium ratio of  $H^-$  to  $H^+$  with the values of Bartels and of Montague and Ribe for the ratio of neutral atom loss cross section to the proton capture cross section. (auth)

2887

STRUCTURE OF ELEMENTARY PARTICLES. Ya. P. Terletskii. *Doklady Akad. Nauk S.S.S.R.* 94, 209-12 (1954) Jan. 11. (In Russian)

The structure, disintegration, mass, spin, and life of various elementary particles are tabulated and discussed. (J.S.R.)

2888

SPECIFIC HEAT OF 96-PERCENT  $He^3$  BELOW 1°K. G. de Vries and J. G. Daunt (Ohio State Univ., Columbus). *Phys. Rev.* 93, 631-2(1954) Feb. 1.

Previous measurements of the specific heat of liquid  $He^3$  (96%  $He^3$ , 4%  $He^4$ ) (Vries and Daunt, *Phys. Rev.* 92, 1572 (1953)) have been extended down to 0.57°K. (L.T.W.)

2889

THE THICKNESS OF THE HELIUM FILM. Lothar Meyer (Univ. of Chicago). *Phys. Rev.* 93, 655-6 (1954) Feb. 15.

It is suggested that the change in thickness of the He film at the  $\lambda$  point is not caused by any essential change in the thermodynamic relation between film thickness, pressure, and temperature. It can be a result of the onset of superfluidity below the  $\lambda$  point which causes a great change in the rate of approach to equilibrium and consequently of the average of the film thickness during the experimental fluctuation of pressure and temperature. (auth)

2890

THE MEASUREMENT AND THE CALCULATION OF THE LIQUID HELIUM VAPOR PRESSURE-TEMPERATURE SCALE FROM 1° TO 4.2°K. R. A. Erickson (Univ. of Tennessee, Knoxville) and L. D. Roberts (Oak Ridge National Lab., Tennessee). *Phys. Rev.* 93, 957-62(1954) Mar. 1.

Measurements between 1.2 and 4.2°K on a paramagnetic salt using a mutual inductance bridge apparatus indicate errors in the presently accepted liquid helium tempera-

ture scale amounting to 12 millidegrees at the  $\lambda$  point. These data, together with those of Kistemaker, are found to be in good agreement with a temperature scale calculated from the other thermodynamic properties of helium. The calculated scale is further confirmed by a comparison between the calculated and observed latent heat of vaporization. Accepting as correct the boiling point determination of Keesom and Clusius, the estimated accuracy of the proposed temperature scale is 1.5 millidegrees below the  $\lambda$  point and 3 millidegrees above the  $\lambda$  point. (auth)

2891

THE VISCOSITY OF GASEOUS  $\text{He}^3$  AND  $\text{He}^4$  BETWEEN 1.3 AND 4.2°K. ON THE QUANTUM STATISTICS OF THE KINETIC COLLISIONS AT LOW TEMPERATURES. E. W. Becker, R. Misenta, and F. Schmeissner (Univ. of Marburg a.d. Lahn and Bayerischen Akademie der Wissenschaften, Herrsching a. Ammersee, Germany). *Z. Physik* **137**, 126-36 (1954) Feb. (In German)

The viscosity of pure gaseous  $\text{He}^3$  and  $\text{He}^4$  was measured in the temperature range from 1.3 to 4.2°K with an automatically registering vibration system. A comparison of the experimental results with the DeBoer and Cohen theory shows that  $\text{He}^4$  obeys the Bose-Einstein statistics, whereas  $\text{He}^3$  obeys the Fermi-Dirac statistics. The nuclear spin of  $\text{He}^3$  is kinematically noticeable. At 2.64 and 4.15°K the concentration dependence of the viscosity on the  $\text{He}^3/\text{He}^4$  mixture was determined. With these measurements as the basis of an expanded theory, the validity of the Boltzmann statistics for the collision of unequal atoms can be proved. (tr-auth)

## ASTROPHYSICS

2892

KINEMATIC PROPERTIES OF THE INTERSTELLAR GAS IN CONNECTION WITH COSMIC RAY ISOTROPY. S. B. Pikel'ner. Translated by E. R. Hope from *Doklady Akad. Nauk S.S.S.R.* **88**, 229-32(1953). 7p. (AEC-tr-1761)

The lack of a discontinuity in the energy spectrum of cosmic rays up to  $10^{17}$  ev is evidence of a magnetic field in interstellar space which is induced by gas clouds about 100 parsecs thick. It is pointed out that such a field must have an intensity greater than  $3 \times 10^{-6}$  oersteds over the entire volume of the galaxy in order to confine the radiation throughout the whole galaxy. These factors, considered with present knowledge on the structure of interstellar gas, lead to the conclusion that the rarefied component must extend to great heights, whereas the dense clouds move in the vicinity of the galactic plane. Such a conclusion indicates that the total mass of interstellar gas is several times greater than previously assumed. By considering the ionization of such a gas, together with probable abundances of Ca and Na atoms, it is shown that the interstellar gas may be detected spectroscopically and may explain the previously reported broadening of super-giant spectra by absorption with the interstellar gas. Two examples of this effect are cited as evidence for the nonstellar origin of this effect. (This paper has been previously title listed in *Nuclear Science Abstracts* as NSA 7-3121.) (K.S.)

2893

SUPERNOVAE AND NOVAE AS SOURCES OF COSMIC AND RADIO RADIATION. V. L. Ginzburg. Translated from *Doklady Akad. Nauk S.S.S.R.* **92**, 1133-6(1953). 5p. (NSF-tr-230)

An abstract of this paper appears in *Nuclear Science Abstracts* as NSA 8-1602.

## COSMIC RADIATION

2894

Iowa State Univ.  
LOW MOMENTUM END OF THE SPECTRUM OF HEAVY

PRIMARY COSMIC RAYS. R. A. Ellis, Jr., M. B. Gottlieb, and J. A. Van Allen. [1953] 56p. (SUI-54-3)

Measurements of the intensity of heavy primary cosmic-ray nuclei have been made above the atmosphere by means of the new Iowa balloon-launched rocket ("rockoon") technique at geomagnetic latitudes  $\lambda = 56, 76$ , and  $86^\circ$ . The measuring instrument was a thin-walled, pulse-ionization chamber of 15 cm diam. The observed data, in conjunction with geomagnetic theory, demonstrate a complete or nearly complete absence of primary heavy nuclei of  $Z \geq 6$  having a magnetic rigidity less than  $1.5 \times 10^9$  v ( $p/mc < 0.8$ ), the result being the most significant for the C, N, O group. It is noted that this spectral cut off occurs at closely the same magnetic rigidity and distinctly not at the same velocity, as the previously reported cut off in the spectra of primary protons and  $\alpha$  particles. (auth)

2895

PAPERS READ AT COSMIC RAY COLLOQUIUM. SEPTEMBER, 1951. *Communs. Dublin Inst. Advanced Studies Ser. A*, No. 10, 195p. (1952)

Papers are presented on the properties of heavy unstable cosmic (V) particles, the properties of heavy charged mesons, the properties and decay of  $\mu$  mesons,  $\mu^-$ -induced fission in U, interpretation of range-energy curves for cosmic radiation, scintillation detectors for delayed particles in air showers, nucleon cascades in Pb, and the penetration of particles in underground showers. (K.S.)

2896

NUCLEAR INTERACTIONS OF SECONDARY SHOWER PARTICLES OF COSMIC RAYS IN LEAD AND CARBON. Isao Kita and Osamu Minakawa (Kobe Univ., Japan). *J. Phys. Soc. Japan* **9**, 6-13(1954) Jan.-Feb.

Nuclear events produced by secondary shower particles of cosmic rays have been observed in a cloud chamber operated at 2,840 m altitude. Pb and C plates were mounted in the chamber, and a comparison was made for penetrating showers originating in these two materials. The results show that the nuclear cross sections for Pb and C are in the ratio of geometrical values. The multiplicities of shower particles in Pb are definitely larger than those in C, and the angular distributions show no differences in both cases. These results can be interpreted if the shower particles contain high-energy protons besides mesons, and the created meson or recoiled proton which is emitted at large angle from the initial direction of the colliding particle has insufficient energy to produce energetic particles. (auth)

2897

FLUCTUATIONS IN THE TRANSITION CURVES OF COSMIC RAY ELECTRONS. L. Bertanza and G. Martelli (Univ. of Pisa, Italy). *Nuovo cimento* (9) **11**, 217-30(1954) Mar. (In English)

Some results of a research program designed to investigate the electromagnetic cascade are given. Transition curves of cosmic-ray electrons at sea level have been determined with great accuracy, using various thicknesses of lead. The results for showers containing at least  $n$  particles ( $n = 1, 2, 3, 4$ ) are compared with the theoretical curves deduced from the Arley cascade model. The experimental results show that the fluctuation distribution fits the Pólya considerably better than the Poisson distribution. (auth)

2898

THE DEPENDENCE OF THE RATIO PHOTONS/ELECTRONS IN SHOWERS OF COSMIC RAYS ON THE AVERAGE DENSITY OF SELECTED SHOWERS. C. Milone (Univ. of Catania, Sicily, Italy). *Nuovo cimento* (9) **11**, 241-9(1954) Mar. (In Italian)

Experiments have been performed at sea level, by means of G-M counters, to study the variation of the ratio photons/electrons ( $f/e$ ), in the extensive air



showers of cosmic rays, as a function of the average density,  $\Delta$ . The results obtained with three different methods show that the ratio  $f/e$  is slightly smaller than unity and decreases slowly when the average density of the showers decreases from about 40 to about 3 particles/ $m^2$ . (auth)

2899

STUDY OF CHARGED K MESONS BY MEANS OF TWO SUPERPOSED WILSON CHAMBERS. B. Gregory, A. Lagarrigue, L. Leprince-Ringuet, F. Muller, and Ch. Peyrou (École Polytechnique, Paris). *Nuovo cimento* (9) **11**, 292-309(1954) Mar. (In French)

Some results on charged heavy mesons are reported. They were obtained with an experimental arrangement consisting essentially of two large cloud chambers placed one above the other. The top chamber had a magnetic field while the bottom chamber was of the multiplate type. The contents of the different sections of the paper can be summarized as follows: 1. The double cloud-chamber method is compared with other more conventional methods. 2. The apparatus is briefly described. 3. The behavior in the multiplate chamber of the charged secondaries of  $V^+$  decays occurring in the top chamber is discussed.  $\pi$  Mesons have been identified through their nuclear interactions. The presence of  $\mu$  mesons is also strongly suggested by: a) the long mean free path of the secondaries and b) one direct mass measurement. 4. S and slow  $V^+$  events observed in the multiplate chamber are discussed. It is shown that one should distinguish between two groups of decays: one with secondaries of range smaller than  $20\text{ g cm}^{-2}$  of Pb, the other with larger range secondaries. Although the first group can be due to  $\tau$  mesons, the second group cannot be so explained, at least not phenomenologically. 5. The results of mass measurements—from range and momentum—on the primaries of the second group of events are presented. The measurements agree with a unique value of  $(914 \pm 20)\text{ m}_e$ , which appears to be different from the  $\tau$  mass. 6. It is shown that some, and probably most, of the secondaries of this second group of events are  $\mu$  mesons. This conclusion is based on the dynamics of the decay and results from the measured mass of the primary particle and the observed ranges of the secondaries. The observation of one large-angle scattering indicates, however, that  $\pi$  mesons may also be present among the secondaries. 7. The data on the range of the charged secondaries are analyzed. If the possible  $\pi^-$  secondary is excluded, the results are in good agreement with a  $\mu$  meson of unique momentum. However, a continuous spectrum, sharply peaked in the high momentum region, is not excluded. 8. The almost complete absence of negative primaries for S events is reported. 9. The results are compared with those obtained elsewhere. They agree with other cloud-chamber results if the existence of  $\pi$  secondaries with a range of  $66\text{ g cm}^{-2}$  of Pb is assumed. The spectrum obtained for the  $\mu$  secondaries does not fit with that of the secondaries of  $\kappa$  particles found in photographic emulsions. (auth)

2900

THREE DIMENSIONAL THEORY OF ELECTRON-PHOTON SHOWERS. B. A. Chartres and H. Messel (Univ. of Sydney, Australia). *Proc. Phys. Soc. (London)* **A67**, 158-66 (1954) Feb. 1.

The method developed by Messel and Green of solving the diffusion equation of the general mixed cascade for the moments of the distribution functions is applied to an electron-photon cascade initiated by a single electron or photon when provision is made for loss of electron energy by ionization. Exact solutions for the Mellin transform of the  $2n$ th angular and  $2n$ th radial moments are given. It is

shown that the  $2n$ th radial moment increases asymptotically as  $n^{4/3}$  and that the radial distribution function is of the form  $\exp(-ar^{1/3})$  for all but the core of the shower. Numerical results are given for the lower moments and compared with previous results. (auth)

2901

EMULSION STUDIES OF COSMIC-RAY STARS PRODUCED IN METAL FOILS. Ian G. Barbour (Kalamazoo Coll., Mich.). *Phys. Rev.* **93**, 535-43(1954) Feb. 1.

A method is described in which cosmic-ray-induced disintegration of nuclei of several elements are studied with metal foils sandwiched between nuclear emulsions placed face to face and exposed at balloon altitudes. The range distributions of low-energy particles are obtained from tracks ending in the emulsion. Calculation of the probabilities of detecting star particles permits conversion of the observed star size distributions to the real size distributions, whose variation with atomic number is presented. The variation with atomic weight of the cross-sections for the production of stars of various sizes is analyzed. The number of tracks per star corresponding to protons in the energy range 25 to 100 Mev is obtained and found to vary approximately as the nuclear radius. (auth)

2902

COSMIC RADIATION IN THE TRAPPED ORBITS OF A SOLAR MAGNETIC DIPOLE FIELD. S. B. Treiman (Princeton Univ., N. J.). *Phys. Rev.* **93**, 544-51(1954) Feb. 1.

One of the well-known consequences which would follow from the existence of an appreciable solar magnetic dipole field is a diurnal variation in cosmic-ray intensity at intermediate latitudes on the earth. For the purpose of calculating the expected diurnal effect, it is first necessary to determine the extent to which the bounded orbits of the solar field are filled by the mechanism which has been discussed by Kane, Shanley, and Wheeler: namely, the scattering of cosmic-ray particles into bounded orbits as a result of magnetic deflection in the earth's field. A calculation of this effect is carried out along the lines indicated by Kane, Shanley, and Wheeler but with several modifications. A solar dipole moment of  $6.5 \times 10^{33}$  gauss-cm<sup>3</sup>, which is implied by the latitude cutoff at the earth, is adopted for the calculations. The cosmic-ray intensity in the trapped orbits is found to be appreciably smaller than indicated in the earlier calculations. Correspondingly, it is expected that the diurnal effect at the earth will be larger than the currently accepted theoretical values. The apparent experimental absence of the effect, although not conclusive, casts doubt on the existence of a solar dipole field as large as  $6.5 \times 10^{33}$  gauss-cm<sup>3</sup>. The present work also provides an estimate of the average time which a cosmic-ray particle would spend in the trapping region. The value 5000 years, previously given, is revised downward by an order of magnitude. (auth)

2903

SOLAR MAGNETIC MOMENT AND DIURNAL VARIATION IN COSMIC-RAY INTENSITY. J. Firor and F. Jory (Univ. of Chicago) and S. B. Treiman (Princeton Univ., N. J.). *Phys. Rev.* **93**, 551-3(1954) Feb. 1.

The expected diurnal variation in cosmic-ray intensity at geomagnetic latitude  $60^\circ$  has been calculated assuming a solar magnetic dipole moment of  $6.5 \times 10^{33}$  gauss-cm<sup>3</sup>. The calculation is based on new estimates of the intensity of cosmic radiation in the trapped orbits of the solar dipole field. The method of Dwight is followed, but with an important modification. The magnitude of the expected diurnal variation turns out to be about 12 percent. (auth)

2904

NEUTRON PRODUCTION BY COSMIC RAYS. William C.G.

Ortel (Yale Univ., New Haven, Conn.). *Phys. Rev.* **93**, 561-7 (1954) Feb. 1.

An experimental study has been made of the production of neutrons in the nuclear interactions of cosmic rays. An apparatus selected events in which a nuclear interaction occurred in or near a liquid scintillation counter, with the production not only of ionizing particles but also of neutrons of a few Mev energy which were slowed to thermal energy in a paraffin moderator and detected by BF<sub>3</sub>-filled proportional counters. Such coincidences are termed (s,n), (s,2n), and so on, according to the number of detected neutrons. The average number  $\bar{\nu}$ , of neutrons produced per disintegration was calculated from the observed relative numbers of (s,n) and (s,2n) coincidences. These data were obtained at Climax, Colorado, at an altitude of 11,200 ft. Analysis shows the events of the type selected in this experiment account for the production of  $3 \times 10^{-4}$  neutrons g<sup>-1</sup> sec<sup>-1</sup>, a figure which is close to the total neutron-production rate in carbon as previously measured at the same location. In these events, it is concluded that  $\bar{\nu} = 1.3 \pm 0.2$ . Combination of this result with previously determined relative multiplicities yields the values  $\bar{\nu} = 2.2$  for production in aluminum and  $\bar{\nu} = 6$  for production in lead. (auth)

2905

STRUCTURE OF AIR SHOWERS. W. E. Hazen (Univ. of Michigan, Ann Arbor), R. W. Williams (Mass. Inst. of Tech., Cambridge), and C. A. Randall, Jr. (Ohio Univ., Athens). *Phys. Rev.* **93**, 578-86 (1954) Feb. 1.

Cosmic-ray air showers of total energy in the range  $10^{14}$  to  $10^{16}$  ev have been studied at 3260-m elevation with a large multiplate cloud chamber in combination with five thin-walled ionization chambers. The spatial distribution of electrons near the shower axis is usually a smooth function of distance with a singularity less marked than  $1/r$ . Evidence is presented, however, to show that some showers have a lumpy structure near the axis. The showers are very poor in high-energy electrons and photons near the axis, relative to the expectation for a single electron-photon cascade. The angular distributions of shower axes are found for various shower sizes and prove to be quite similar to those expected for single electron-photon cascades. The implications for various shower models are discussed, and a fairly extensive nucleonic cascade is indicated. (auth)

2906

THE ZENITH ANGLE DEPENDENCE OF COSMIC-RAY PROTONS. Charles E. Miller, Joseph E. Henderson, David S. Potter, Jay Tood, Jr., Wayne M. Sandstrom, Gerald R. Garrison, William R. Davis, and Francis M. Charbonnier (Univ. of Washington, Seattle). *Phys. Rev.* **93**, 590-5 (1954) Feb. 1.

The proton spectrum for particles in the momentum band 0.4 to 1.0 bev/c and the meson spectrum for particles in the momentum band 0.09 to 0.34 bev/c at zenith angles 45° east, vertical, and 45° west have been obtained at 3.3-km elevation and magnetic latitude 48° north. The zenith angle dependence of protons, along with a simplified analysis, is presented as data on the nucleonic cascade. It is found that the gross zenith angle dependence will fit a  $\cos^{3.2}\theta$  distribution at 45° east and west, there being no statistically significant east-west asymmetry. The simplified calculation assumes that a unidirectional component of the primary radiation will (1) suffer exponential absorption along its original path with a path length for removal of 120 g/cm<sup>2</sup> of air and (2) acquire an ultimate distribution at 3.3 km due to scattering fitting a  $\cos^n\omega$  law, n being an adjustable parameter. It is found that a value of n of  $6.5 \pm 0.7$  yields a unidirectional distribution which, when integrated over all

angles, results in a gross zenith angle dependence agreeing with  $\cos^{3.2}\theta$ . The  $\cos^n\omega$  distribution with n equal to 6.5 is quite sharp and leads to the conclusion that the average projected scattering angle per collision is only about 6°. (auth)

2907

GEOMAGNETIC AND ALBEDO STUDIES WITH A ČERENKOV DETECTOR AT 40° GEOMAGNETIC LATITUDE. J. R. Winckler and K. Anderson (Univ. of Minn., Minneapolis). *Phys. Rev.* **93**, 596-605 (1954) Feb. 1.

A Cherenkov detector consisting of a Lucite radiator optically sealed to a large-area side-window photomultiplier has been flown at  $\lambda = 40^\circ$  at a depth of 25 g/cm<sup>2</sup> below the top of the atmosphere. The albedo was determined and is not more than 5 percent of the incident flux for particles of  $\beta > 0.7$  in any upward direction. The albedo observed is too small to account for the factor-of-two difference between the observed E-W asymmetry and that predicted from the primary spectrum and geomagnetic theory. Direct asymmetry measurements by the Cherenkov counter suggest that the earth shadow cone cutoff may start at larger zenith angles than theoretically predicted. A very rough relative abundance measurement of H:He:Li gives 1:0.08:0.02. (auth)

2908

INFLUENCE OF THE EARTH'S MAGNETIC FIELD ON THE EXTENSIVE AIR SHOWERS. Giuseppe Cocconi (Cornell Univ., Ithaca, N. Y.). *Phys. Rev.* **93**, 646-7 (1954) Feb. 1.

This note points out that the displacement from the rectilinear path produced by the action of the earth's magnetic field on the electrons ( $\pm$ ) of an extensive air shower can not be negligible in comparison with the displacement due to Coulomb scattering. (auth)

2909

THE INTERACTION AND PRODUCTION OF COSMIC-RAY PROTONS IN CARBON. J. Ballam and P. G. Lichtenstein (Univ. of California, Berkeley). *Phys. Rev.* **93**, 851-7 (1954) Feb. 15.

Protons in cosmic radiation at sea level were observed under varying thicknesses of C absorber. In the energy range 150 to 570 Mev an interaction mean free path for protons was estimated from the ratio of those emerging from the absorber to those incident upon the absorber and is greater than 140 g/cm<sup>2</sup> in C. The spectrum of protons produced in the C by neutral cosmic radiation permits the inference of the flux of neutrons in the cosmic radiation, with the result that neutrons with momenta greater than 550 Mev/c are 6% as abundant as all ionizing cosmic radiation at sea level. (auth)

2910

DIFFERENTIAL RANGE SPECTRUM OF COSMIC-RAY MESONS AT SEA LEVEL. Philip G. Lichtenstein (Univ. of California, Berkeley). *Phys. Rev.* **93**, 858-60 (1954) Feb. 15.

Operation of a cosmic-ray mass-measuring equipment under 8.8 in. of C absorber for 123 hr of sensitive time yielded 495 stopping mesons identifiable by their momentum vs. residual range. After correction for zenith-angle and solid-angle dependence of the stopping particles, it is found that the spectrum of  $\mu$  mesons for residual ranges 40 to 105 g/cm<sup>2</sup> air equivalent is flat and has an intensity of approximately  $6.0 \times 10^{-6}$ /g-sec-sterad. It is shown that the results of York, when corrected for a very heavy background of electrons at small ranges, yield a  $\mu$ -meson spectrum in good agreement with the present work. (auth)

2911

ANGLE OF DIVERGENCE OF PAIRS PRODUCED BY PHOTONS. K. Hintermann (Univ. of Berne, Switzerland). *Phys. Rev.* **93**, 898-9 (1954) Feb. 15.



Nuclear emulsions (Ilford G5, 600 $\mu$ ) were exposed for three weeks at an elevation of 4550 m and systematically scanned for high-energy electron pairs produced by  $\gamma$  rays from cosmic radiation. Plots are shown of the pair distributions and the correlation between angle of divergence and photon energy, and results are compared with theoretical predictions. (L.M.T.)

2912

A ČERENKOV COUNTER-CLOUD CHAMBER MEASUREMENT OF MULTIPLY-CHARGED PRIMARY COSMIC RAYS. John Linsley (Univ. of Minnesota, Minneapolis). *Phys. Rev.* **93**, 899-900 (1954) Feb. 15.

The flux of fast particles with  $Z \geq 2$  was measured at balloon altitude and 55° N geomagnetic latitude by means of a cloud chamber triggered by a Cherenkov counter. At this latitude the energy spectra of the particles detected were cut off by the Cherenkov detector rather than geomagnetic effects. The mean threshold energy for He nuclei entering the counter was  $650 \pm 100$  Mev/nucleon entering the counter. To consider flux above the atmosphere corrections were made for energy thresholds for ionization loss in the material above the Cherenkov counter, and nuclear interactions were taken into account in all material above the cloud chamber sensitive volume (17 g/cm<sup>2</sup> air, 13 g/cm<sup>2</sup> local matter). (L.M.T.)

2913

A DOUBLE STAR CONNECTED BY A HEAVY MESON. S. Rosendorff, R. Stahl, and G. Yekutieli (Israel Atomic Energy Commission, Tel Aviv). *Phys. Rev.* **93**, 901 (1954) Feb. 15.

A double star connected by a heavy meson (mass 1310  $m_e$ ) was observed in an Ilford G5 plate exposed to cosmic radiation at 30 km. The first star was a  $4 + 4\alpha$  star induced by an  $\alpha$  particle of 5 Bev. The heavy meson traveled 34 mm producing a  $5 + 0K$  secondary star. Together with the heavy meson a proton is produced in the same nuclear collision. The proton travels in the emulsion in the direction of the heavy meson and leaves the emulsion after 6.4 mm. In the course of the measurements six other heavy mesons with mass between 1000 and 1300  $m_e$  were found. (L.M.T.)

2914

ON H. ALFVÉN'S THEORY OF THE EFFECT OF MAGNETIC STORMS ON COSMIC-RAY INTENSITY. W. F. G. Swann (Franklin Inst., Swarthmore, Penna.). *Phys. Rev.* **93**, 905-6 (1954) Feb. 15.

Alfvén (*Phys. Rev.* **75**, 1732(1949)) calculated the energy change of a  $3 \times 10^{10}$  ev cosmic ray in crossing a gas stream  $5 \times 10^{12}$  cm wide and travelling with a velocity  $v$  of  $2 \times 10^8$  cm/sec. For a stationary observer this change amounted to 10%. This note recognizes that an observer moving with the beam observes no change of energy, and by a relativity transformation it is shown that a fixed observer cannot observe a change of energy greater than  $2vW/c$ , where  $W$  is the energy of the cosmic ray. This change amounts to only  $\sim 1.4\%$ . (L.M.T.)

2915

NUCLEON-NUCLEUS COLLISIONS AT RELATIVISTIC ENERGIES. Giuseppe Cocconi (Cornell Univ., Ithaca, N. Y.). *Phys. Rev.* **93**, 1107-8(1954) Mar. 1.

The Fermi theory of multiple meson production is utilized in the interpretation of high-energy collisions between nucleons and complex nuclei. A relation between the total number of relativistic particles produced, their angular spread, and the number of nucleons involved in the collision is found to be satisfied by all the cases of relativistic showers published thus far. (auth)

## ELECTRICAL DISCHARGE

2916

OSCILLOGRAPHIC INVESTIGATION OF SPARK DISCHARGE. I. S. Abramson and N. M. Gegechkori. Translated from *Zhur. Eksptl'. i Teoret. Fiz.* **21**, 484-92(1951). 10p. Available from Associated Technical Services (Trans. RJ-152), East Orange, N. J. (AEC-tr-1833)

Results are given of an oscillographic recording of voltage and current of a spark discharge in an intermediate stage of the discharge. On the basis of these data, relationship is established between the rate of energy liberation in the discharge gap and the circuit parameters, namely, self-inductance, capacitance, and voltage. (auth)

2917

BROADENING OF THE CHANNEL OF AN IMPULSE DISCHARGE IN INERT GASES. K. S. Vul'fson and I. Sh. Libin. Translated from *Zhur. Eksptl'. i Teoret. Fiz.* **21**, 510-13(1951). 4p. Available from Associated Technical Services (Trans. RJ-151), East Orange, N. J. (AEC-tr-1834)

With the aid of a rotating mirror display, the speed of broadening of the channel (canal) of an impulse (transient) discharge in argon, krypton, and xenon has been measured. Glow of the gas under the influence of a reflected shock wave has been discovered. A case of the formation of two separate channels in the gas is described. (auth)

2918

THE EXCITATION OF PLASMA OSCILLATIONS. Duncan H. Looney and Sanborn C. Brown (Massachusetts Inst. of Tech., Cambridge). *Phys. Rev.* **93**, 965-9(1954) Mar. 1.

A beam of high-energy electrons, injected into the plasma of a dc discharge from an auxiliary electron gun, excited oscillations in the plasma at the plasma electron oscillation frequency given by the Tonks-Langmuir equation. A movable probe showed the existence of standing-wave patterns of the oscillator energy in the region of the plasma in and around the electron beam. Nodes of the patterns coincided with the electrodes which limited the region of the plasma traversed by the beam. The standing-wave patterns were independent of the frequency of the oscillation. At any particular frequency, the standing wave was determined by the thickness of the ion sheaths on the bounding electrodes. The mechanism of the energy transfer from the electron beam to the oscillation of the plasma electrons was established as a velocity-modulation process by the detailed behavior of the frequency of oscillation and the transitions in the standing-wave patterns as the sheath thickness was varied. Experimental attempts to produce plasma oscillations as predicted by Bohm and Gross proved to be fruitless. (auth)

## ELECTRONS

2919

ON THE EXCITATION OF OSCILLATIONS IN A THERMAL PLASMA. Masao Sumi (Electrical Communication Lab., Tokyo, Japan). *J. Phys. Soc. Japan* **9**, 88-92(1954) Jan.-Feb.

Ionized gas neutralized on the average plasma oscillations is considered for an arbitrary distribution of electron beams. Under the assumption of small signal and of the absence of any static fields, the fundamental equations are derived in a one-dimensional treatment. The dispersion relation obtained from the fundamental equations is found to describe the behavior of propagation of localized initial disturbances with electron beams. It is applied to the case of excitation of thermal plasma by an injected electron beam, and the rate of wave growth is obtained. The numerical results are compared with the circumstances corresponding

to the investigation by Merrill and Webb. Abrupt scattering of the electron beam observed may be ascribed to the excitation of plasma oscillations. (auth)

2920

AN EQUATION WITH A FINITE DIFFERENCE FOR THE CLASSIC ELECTRON. F. Duimio (Univ. of Milan, Italy). *Nuovo Cimento* (9) 11, 326-9(1954) Mar. (In Italian)

It is shown how the Caldirala equation (*Nuovo cimento* 10, 1747(1954)) with a finite difference, relativistically invariant, for the description of the classic motion of an electron in an external field can be related to a particular form of interaction between an electromagnetic field and an electron. (J.S.R.)

2921

THE MECHANISM OF SECONDARY ELECTRON EMISSION. A. O. Barut (Univ. of Chicago). *Phys. Rev.* 93, 981-4(1954) Mar. 1.

It is shown that a simple theory based on the constant energy loss per unit path length of primary electrons accounts quantitatively for the variation of secondary electron emission yield below its maximum value. The theory can be extended formally to include a Bethe-type energy loss at high primary energies. An attempt was made to clarify the present situation concerning the relationship between the secondary electron emission and the atomic structure of the elements, and some new relations are indicated. The mechanism of the secondary emission of insulators and semiconductors is also discussed. (auth)

## GASES

2922

Los Alamos Scientific Lab.

THE HUGONIOT OF GASES BY SHOCK WAVE MEASUREMENTS. Russell H. Christian and Robert G. Shreffler. [1953] Decl. Jan. 18, 1954. 11p. Contract [W-7405-eng-36]. (AEC-3622)

Equation-of-state data are derivable from the simultaneous measurement of the velocity of a plane shock front through a gas and the velocity of the plate that generates the shock. The present experimental method employs a high-explosive lens system to accelerate the plate into the gas. Velocities are recorded by a high-speed moving-image camera with precisions of the order of 0.5%. A series of such experiments determines the experimental shock velocity vs. particle velocity curve for a given gas. The method permits measurements using shocks in the pressure region of approximately 200 to 1000 atm. The lower limit is defined by the failure of the gas to become luminescent on reflection. The upper limit is determined by the maximum particle velocity attainable with high explosives. Experimental data have been obtained for air, A, He, and N. The Rankine-Hugoniot shock equations are used to convert the experimental data to pressure-compression data which define the Hugoniot curve. A comparison may now be made to theoretical predictions. Air is shown to agree, within experimental error and up to the maximum pressure attained, with the Hugoniot calculated from the report by H. A. Bethe "The Specific Heat of Air up to 25,000°C." (auth)

2923

National Bureau of Standards

THE EFFECT OF DISSOCIATION ON THE THERMODYNAMIC PROPERTIES OF PURE DIATOMIC GASES.

Harold W. Woolley. [May 1, 1953]. 25p. (NBS-1884)

A graphical method for obtaining charts for the thermodynamic properties, enthalpy and entropy, for the equilibrium mixture of atoms and diatomic molecules for pure gaseous elements is described. The procedure is equivalent in principle to numerical calculation based on the same funda-

mental data but gives directly the location of points of intersection of curves for constant pressure and curves for constant values of PV/RT. In combination, the resulting graphs for enthalpy and entropy are equivalent to Mollier diagrams for the gaseous fluid in the dissociation region. Results are given for H<sub>2</sub>, O<sub>2</sub>, and for the 2 principal estimates for dissociation energy for N<sub>2</sub>. A table of equilibrium constants is included for the reactions H<sub>2</sub> → 2H, O<sub>2</sub> → 2O, and N<sub>2</sub> → 2N. The effect of dissociation on the heat capacity is also discussed briefly. (auth)

## INSTRUMENTS

2924

Los Alamos Scientific Lab.

NON-REACTOR ELECTRONICS AT LOS ALAMOS. R. J. Watts. [1953] 22p. Contract [W-7405-eng-36]. (AECU-2830)

Electronics activities at Los Alamos are illustrated by a presentation on the design and performance data of a Hg pulse generator, a multichannel analyzer, and an over-loadable amplifier. (K.S.)

\*2925

Hanford Works

AN ELECTRONIC HIGH VOLTAGE SUPPLY. W. G. Spear. Feb. 1, 1954. 12p. Contract W-31-109-Eng-52. (HW-30712)

A miniature high voltage supply, suitable for replacement of vibrators in portable G-M counters, has been developed and tested. It delivers 900 volts d-c at 5  $\mu$ a for 150 hours per battery set and has a comparatively sharp end-point. Initial cost is low, and all components are readily available standard items. (auth)

\*2926

Carbide and Carbon Chemicals Co. (K-25)

TEMPERATURE REGULATOR FOR A RESEARCH FURNACE OPERATING BETWEEN 500° AND 600°C. J. H. Lykins and H. S. McKown. Mar. 12, 1954. 12p. Contract W-7405-eng-26. (K-1109)

A temperature regulator was required for a research furnace which would operate in the range from 500 to 600°C with a regulation of  $\pm 0.5^\circ\text{C}$ . The maximum power required by the furnace was 50 kw. In order to achieve this regulation the final design incorporated supply voltage and temperature regulators. (auth)

\*2927

Mound Lab.

A DIRECT-CURRENT CONSTANT-POWER POWER SUPPLY. (INFORMATION REPORT). T. L. Zinn, J. W. Heyd, W. L. Hood, and J. A. Williamson. Sept. 5, 1953. 11p. Contract AT-33-1-GEN-53. (MLM-911)

A 1-w d-c power-regulated power supply was designed and tested. A control signal proportional to the power was obtained by adding signals proportional to the logarithms of the load current and voltage. This control voltage regulates the output of grid-phase-shift-controlled thyatron rectifiers. The power was held constant at approximately 1 w for current and voltage variations of less than 1 decade each. Increased control amplifier gain could extend this to 2 decades, the range of the log amplifiers. A d-c supply of 1 amp at 1,000 v, with additional amplifier gain, was designed but not built. The print numbers of this design are included. (auth)

2928

Battelle Memorial Inst.

ELECTRONIC GAS DISCHARGE TUBES. PROGRESS REPORT [FOR JUNE 15 TO SEPTEMBER 15, 1952]. J. E. Drennan, G. B. Gaines, and F. C. Todd. Sept. 15, 1952. 36p. (NP-4733)

Studies on the development of voltage-regulator tubes are



described. The influence of gas pressures, gas mixtures (Ne-A), and electrode shapes and spacings is emphasized. An experiment is proposed in connection with the cleanup of Mo surfaces, measuring the ratio of A atoms trapped in metal to the number of A ions incident on the metal. Instrumentation connected with this experiment is described. (K.S.)

2929

Research Lab. of Electronics, Mass. Inst. of Tech.  
NOISE FIGURE OF TRAVELING-WAVE TUBES. Charles Edward Muehe, Jr. Oct. 16, 1952. 39p. Contract DA-36-039-sc-100, Technical Report No. 240. (NP-5111)

2930

Rochester Univ.  
A HIGH-GAIN MULTI-STAGE 100 Mc. DISTRIBUTED AMPLIFIER. Kurt Enslein. Feb. 18, 1954. 10p. Contract AT(30-1)-875. (NYO-6231)

The design and performance of a high-gain multistage 100-Mc distributed amplifier for a scintillation counter are described. The frequency response of the amplifier is in the range 10 to 200 Mc, and its linearity is good up to an output of approximately 8 v. (J.A.G.)

2931

Radiation Lab., Univ. of Calif., Berkeley  
EXTENDING THE RANGE OF A SELF-BALANCING RECORDING POTENTIOMETER WITHOUT REDUCING RESOLUTION. H. B. Keller and C. G. Dols. Jan. 11, 1954. 14p. Contract W-7405-eng-48. (UCRL-2049(Rev.))

The combination of the "Lobetrol" (an assembly of relays, switches, etc.) with a commercial recorder (such as Leeds and Northrup Type G Speed-O-Max) constitutes a self-balancing, indicating, and recording potentiometer whose range is a multiple of the range of the commercial recorder. The resolution of the combination is equal to the resolution of the recorder. (auth)

2932

TRANSVERSE CONVERGENCE CREATED BY THE SLITS OF ION OPTICAL INSTRUMENTS. (Convergence Transversal Créé par les Fentes Des Instruments D'Optique Ionique). Francois Bertein. Translated from *Compt. rend.* 231, 766-7(1950). 4p. (NRL-Trans-364)

An abstract of this paper appears in *Nuclear Science Abstracts* as NSA 5-1298.

2933

NEW PHOTOMULTIPLIERS AND OPERATING DATA. Bernard R. Linden (Allen B. Du Mont Labs. Inc., Passaic, N. J.). *Nucleonics* 12, No. 3, 20-3 (1954) Mar.

Operating data on 5-,  $\frac{3}{4}$ -, and  $\frac{1}{4}$ -in. Du Mont photomultiplier tubes are given, and the use of wide dynodes to improve gain is discussed. Construction of a 16-in. tube and the use of a flying-spot scanner to study tubes that are in production are reported. (C. H.)

## MASS SPECTROGRAPHY

2934

Chalk River Project (Canada)  
A BIBLIOGRAPHY OF MASS SPECTROMETRY REFERENCES. Oct. 15, 1953. 57p. (PDB-95(add.))

A card index of mass spectrography literature is presented, which includes 659 references. The card index numbers and the corresponding references are listed in numerical order. This section (C) is provided for use in conjunction with section B, which identified references by number only. (J.A.G.)

## MATHEMATICS

2935

Research Lab. of Electronics, Mass. Inst. of Tech.  
A COMPUTER FOR SOLVING INTEGRAL FORMULATIONS OF ENGINEERING PROBLEMS BY METHODS OF SUCCESSIVE APPROXIMATIONS. J. M. Ham. May 28, 1953. 57p. Contract DA36-039-sc-100, Technical Report No. 241. (NP-5112)

Variational methods of successive approximations for solving the linear operational equation  $P\alpha + \beta = 0$  are examined, where P is an  $n \times n$  matrix,  $\beta$  is a known vector, and  $\alpha$  is an unknown vector. The equation is used to represent linear simultaneous equations, integral equations, and boundary value problems in differential equations. The variational principle informing the methods of solution is that of associating with the basic equation a scalar-valued functional  $W(\alpha)$  that attains its extrema when the equation is satisfied;  $W(\alpha)$  defines a surface over the n-space of the operator P. In this space, the solution sequences  $\alpha_0, \alpha_1, \dots, \alpha_m$  generated by relaxation and classical iterative methods describe particular types of vector trajectories that terminate under the extrema of  $W(\alpha)$ . A computer is described which consists of one standard relay rack of computing components and an input-output desk station. The inputs and outputs are in the form of paper tapes punched in binary code. The internal operations are in part digital and in part analog. The major mathematical function performed by the machine is that of transforming an n-vector by an  $n \times n$  matrix. A 40-vector may be so transformed in approximately 40 seconds. The machine carries 9 binary digits. The machine is effective for evaluating integral transformations such as Fourier, correlation, and convolution integrals. (auth)

2936

Oak Ridge National Lab.  
NUMERICAL COMPUTATION OF THE CHARACTERISTIC VALUES OF A REAL SYMMETRIC MATRIX. Wallace Givens. Mar. 3, 1954. 113p. Contract W-7405-eng-26. (ORNL-1574)

## MEASURING INSTRUMENTS AND TECHNIQUES

2937

Chicago Univ.  
SENSITIVE RADIATION DETECTION TECHNIQUES FOR TRITIUM, NATURAL RADIOACTIVITIES, AND GAMMA RADIATION. FINAL REPORT. W. F. Libby. Dec. 1, 1951. 40p. Contract AF-33-(038)-18013. (ATI-133901)

Methods of measurement of the activity of tritium at concentrations of one tritium atom for  $10^{18}$  ordinary H atoms were investigated. A method was developed in which a volume of several liters of water is electrolyzed to a volume of 1 or 2 cc and the water in the residual 1 or 2 cc is converted to H gas which is counted in a Geiger counter filled with a  $C_2H_4-A-H_2$  mixture. The method is said to have an efficiency that is virtually unity. Applications of the counting technique to determinations of the tritium content of natural waters on a world scale and tracer experiments with tritium are discussed. The photosensitivity of Geiger counters and attempts to observe double  $\beta$  decay and its relationship to natural radioactivities were also investigated. (C.H.)

2938

Commissariat à l'Énergie Atomique (France)  
COMPTEURS DE GEIGER A RAYONS GAMMA A CATHODE DE BISMUTH. [Gamma Ray Geiger Counters Using a Bismuth Cathode]. R. Meunier and J. P. Legrand. Dec. 1953. 6p. (CEA-239)

Geiger-Mueller counters have a low efficiency, in the order of a few percent, for  $\gamma$  radiation. In the region of 0.3 to 1 Mev a substantial increase in performance can be obtained by a special cathode construction. Several counters were constructed with a cathode made of Cu which was electrolytically plated with Bi. (tr-auth)

2939

Commissariat à l'Énergie Atomique (France)  
ENSEMBLE DE COMPTAGE  $\alpha$  a CHAMBRE d'IONISATION  
a IMPULSION. [An Alpha-Counting Apparatus Using a  
Pulse Type Ionization Chamber]. J. Engelman and H.  
Guillon. Dec. 1953. 11p. (CEA-241)

The theoretical study and design of an  $\alpha$ -counting apparatus using a pulse type ionization chamber is described. The apparatus is used to control chemical separations by  $\alpha$  measurement in the presence of  $\beta$  particles. The chamber, amplifier, and discriminator, as well as the causes of error, are described in detail. (J.S.R.)

\*2940

Ames Lab.  
A COINCIDENCE SCINTILLATION SPECTROMETER.  
Sven A. E. Johansson. Dec. 9, 1953. 21p. Contract W-7405-eng-82. (ISC-431)

The coincidence spectrometer consists of two scintillation spectrometers, each of which can be used as either a  $\beta$ -ray or a  $\gamma$ -ray spectrometer, depending on what crystals are used. The pulses from the first spectrometer are analyzed with a single-channel analyzer. The pulses corresponding to a certain energy are picked out with the analyzer and are fed into one channel of a coincidence circuit. The pulses from the second spectrometer are fed into the other channel of the circuit. The coincidence output pulses are used to trigger an oscilloscope. The pulses from the second spectrometer are displayed on the screen of the scope. Because the oscilloscope is triggered by the coincidence circuit, only those pulses from the second spectrometer which are in coincidence with the selected pulses from the first spectrometer are seen. The pulse distribution of the displayed pulses is recorded by photographic methods. Gamma-ray spectra are recorded by taking still pictures of the screen. Beta-ray spectra are recorded by photographing the screen with a movie camera, so that each individual pulse is recorded separately. (auth)

2941

Livermore Research Lab., Calif. Research and Development Co.  
HIGH SPEED COUNTING USING THE E1T DECADE COUNTER TUBE. R. E. Nather. Mar. 1954. 18p. Contract AT(11-1)-74. (LRL-103)

High-speed counting circuits using E1T decade counter tubes are described. Modifications to the Philips circuit permits counting rates of over 100,000 pulses per second with no loss of reliability. Also circuits for use of the E1T tube to scale to less than ten are described. Circuit diagrams are given. (auth)

\*2942

Health and Safety Lab., New York Operations Office, AEC  
EFFECT OF AGE ON THE REPRODUCIBILITY OF FILM BADGE DENSITY READINGS. Keran O'Brien and Leonard Solon. Feb. 1954. 5p. (NYO-4576)

Film exposed and developed during the period July 3, 1950 to July 9, 1951, were reread in Nov. 1953, and the readings were compared with the previous results. Although the later readings were slightly lower than the original ones, it was concluded that the density stability of developed film badges remains essentially unimpaired for at least three years. (J.S.R.)

\*2943

Health and Safety Lab., New York Operations Office, AEC  
"DEEDLEBUG"—A GAMMA RAY DRILL HOLE LOGGING PROBE UNIT. H. D. LeVine and Ole Pedersen. Feb. 25, 1954. 5p. (NYO-4578)

The drill hole logging probe to fit holes  $1\frac{1}{8}$ " diameter or less where one may seek ore grade rock containing uranium is lightweight, simple, and requires a minimum of circuitry;

the probe is waterproof and can be used at the end of 2000 feet or more of cable. The probe and cable are designed to go into wet holes and where necessary can be provided with a threaded end adapter for push rod use or a weighted sleeve for free fall into a hole. (auth)

\*2944

Oak Ridge National Lab.  
THE CHARACTERISTICS OF AN ELECTRON MULTIPLIER AS A DETECTOR OF HEAVY PARTICLES. Clarence F. Barnett. Feb. 15, 1954. 84p. Contract W-7405-eng-26. (ORNL-1669)

It is suggested that the shortcomings of conventional counting techniques for the measurement of low-energy heavy particles can be overcome by the use of electron multipliers. A program to determine the effect of various parameters (pressure, aging, current, voltage, etc.) on the response of multipliers used for such applications is described. The gain and efficiency of the system are also considered from the quantitative standpoint, whereby mass and energy analyses may be made. (K.S.)

\*2945

Radiation Lab., Univ. of Calif., Berkeley  
A LINEAR, TRANSPARENT BEAM INTEGRATOR. Sumner W. Kitchen. Feb. 12, 1954. 7p. Contract W-7405-eng-48. (UCRL-2495)

A fast, linear, air-ionization chamber has been developed for integrating and monitoring external heavy-particle beams. It consists of a thin-windowed air chamber in which the beam ionization light is viewed by a photomultiplier whose output is fed directly to a standard electrometer. (auth)

2946

A NUCLEAR SPECTROMETER FOR HEAVY PARTICLES II. PERFORMANCE AND FOCUSING PROPERTIES. Curt Mileikowsky (Nobel Inst. of Physics, Stockholm). *Arkiv Fysik* 7, 33-46(1954).

An experimental investigation of the heavy-particle nuclear spectrometer described in NSA 7-1192, covering image position, line width, dispersion, and solid angle, has shown that the instrument functions to a fairly good approximation as a conical sector field. (J.S.R.)

2947

A NUCLEAR SPECTROMETER FOR HEAVY PARTICLES. II. ASTIGMATIC TWO-DIRECTIONAL FOCUSING IN A NUCLEAR SPECTROMETER AS A MEANS OF ELIMINATING LINE BROADENING DUE TO ANGULAR ENERGY SPREAD OF TRANSMUTATION PARTICLES. Curt Mileikowsky (Nobel Inst. of Physics, Stockholm). *Arkiv Fysik* 7, 57-68(1954)

By means of a slightly astigmatic two-directional focusing system, particles can be focused through a large solid angle to a tilted line image of definite length. The line is not broadened by the variation of energy with emitting angle that is caused by the motion of the center of mass. The solid angle is very nearly the same as the solid angle of the anastigmatic case. If  $n$  is chosen larger than 0.50, the resolution is somewhat more favorable than the anastigmatic resolution. The line slope to the axial direction may facilitate to some extent the identification of the reaction that caused the particular particle group. Also, the determination of the Q-value is independent of any assumption or measurement on the angular distribution of intensity of the reaction. (auth)

2948

OBSERVATIONS ON THE IONIZATION PRODUCED BY RADIUM GAMMA RAYS IN AIR-WALLED IONIZATION CHAMBERS AT LOW GAS PRESSURES. C. W. Wilson (Westminster Hospital, London). *Brit. J. Radiol.* 27, 158-62(1954) Mar.



2949

# A CONTRIBUTION TO THE THEORY OF IONIZATION CHAMBER MEASUREMENTS AT LOW PRESSURES.

J. R. Greening (St. George's Hospital, London). *Brit. J. Radiol.* **27**, 163-70 (1954) Mar.

The ionization chamber measurements of other workers at low pressures have indicated (i) that the measured current is in excess of that to be expected on the Bragg-Gray theory; (ii) that there is a residual current even at sensibly zero pressure; (iii) that the gradient of the ionization-pressure curve at low pressures is less than that at atmospheric pressure, and (iv) that the saturation curves of chambers at low pressures are often grossly asymmetrical. Effects (i) and (ii) are attributed to the deflection by the chamber voltage of slow electrons emitted from the chamber walls. Expressions are derived for the number of electrons deflected between plane, spherical and cylindrical electrodes. The numbers of electrons emitted/cm<sup>2</sup>/r deduced from ionization chamber measurements are found to agree, within a factor of 2, with the corresponding numbers derived indirectly from other data, and are approximately  $5 \times 10^5$ /cm<sup>2</sup>/r and  $1 \times 10^6$ /cm<sup>2</sup>/r for graphite and elektron metal respectively irradiated by radium  $\gamma$  rays. The approximate energy distribution of these slow electrons is indicated. Effect (iii) is attributed to the difficulty of achieving saturation without producing ionization by collision. At low chamber volts some ions have sufficient energy to reach the electrode of the same polarity. Effect (iv) is attributed to differences in electrode areas and the asymmetry of the electric field between the electrodes. An example of a calculated saturation curve is given for spherical electrodes. Finally it is suggested that similar effects would occur at atmospheric pressure in chambers having extremely small electrode separations. (auth)

2950

# A MULTI-TUBE GAMMA COUNTING APPARATUS FOR SMALL SAMPLES. N. Veall and A. M. Baptista (Hammersmith Hospital, London). *Brit. J. Radiol.* **27**, 198-9 (1954) Mar.

A multi-tube  $\gamma$ -counting apparatus for use with small liquid samples is described, and data are included on the sensitivity of the apparatus. (C.H.)

2951

# COUNTING SLOW ELECTRONS WITH AN ELECTRON MULTIPLIER. J. A. Cowan (Univ. of Toronto, Ontario). *Can. J. Phys.* **32**, 101-9 (1954) Feb.

The efficiency of counting slow velocity electrons by a 12-stage activated beryllium-copper electron multiplier was investigated. The total electron current in the incident beam was measured using an electrometer tube circuit. The number of pulses produced in the multiplier by the whole beam was counted using high speed scaling circuits. The efficiency of counting was thus determined without depending on calibrated slits to divide the beam. Efficiency curves for primary energies between 200 and 900 eV are shown for freshly activated surfaces and also for surfaces which had been exposed to still air for five months. The curves were similar in shape, the former being a few per cent above the latter. A maximum of 63% was obtained for 300 eV input energies. (auth)

2952

# ELECTRONIC DETECTORS OF NUCLEAR RADIATIONS. Jacques Labeyrie (Saclay Center of Nuclear Studies, France). Sect. E-1060 of *Electronique*, Vol. 2. Techniques de l'Ingenieur, Paris. (1953) 14p. (In French)

The properties and characteristics of radiation detection instruments for  $\alpha$ ,  $\beta$ , and  $\gamma$  radiation are reviewed. (K.S.)

2953

# RESPONSE OF A PULSED GEIGER TUBE. Herbert B. Rosenstock (Naval Research Lab., Washington, D. C.) *J. Appl. Phys.* **25**, 275-82 (1954) Mar.

For the purpose of extending the usefulness of a Geiger counter to higher radiation intensities, it has been suggested that the voltage applied to its electrodes be a periodically repeated pulse rather than the usual d-c. If the duration of the pulse is of the order of the spread time of the discharge in the tube, the output current vs. radiation intensity relation will differ from the usual linear one, largely because the resulting current surge may not reach its maximum before the end of the applied pulse. This relation will therefore depend, among other factors, on the not fully understood mechanism by which the discharge spreads. Using probability considerations, this relation was calculated as a function of the response of the tube under ordinary operation. If the discharge spreads rapidly (e.g., exponentially) initially, an approximate general relationship not involving the detailed spread mechanism may be established. The response to be expected in two types of tubes is discussed in detail, using models for the spread mechanism which are mathematically simplified though probably physically adequate. (auth)

2954

# OPTIMUM AND LIMITING OPERATING CONDITIONS FOR DOWNWARD DIFFUSION CLOUD CHAMBERS.

A. R. Bevan (Atomic Energy Research Establishment, Harwell, Berks, England). *J. Sci. Instr.* **31**, 45-9 (1954) Feb.

Measurements on a diffusion cloud chamber operated with fillings up to pressures of 11 atm. are interpreted according to a theoretical treatment by Shutt. The results can be used to determine temperature conditions required for good operation with any permanent gas at all useful pressures and for any given mean radiation intensity. Factors which interfere with normal operating conditions are considered. (auth)

2955

# PHOTOVOLTAIC SCINTILLATION DETECTOR FOR HIGH DOSE RATES. R. L. Schuch, R. D. Hiebert, F. N. Hayes, and Betty Rogers (Los Alamos Scientific Lab., New Mexico). *Nucleonics* **12**, No. 2, 16-18 (1954) Feb.

Design and performance data are reported for a combination of photovoltaic cell and liquid or solid plastic scintillators. Simplicity of use and high light output are reported to make this unit a practical radiation detector giving a linear response in the range from 12,000 to 360,000 r/hr, with an estimated accuracy of 4%. (C. H.)

2956

# DENSITY EFFECT IN $\gamma$ -RAY MEASUREMENTS. G. N. Whyte (National Research Council of Canada, Ottawa). *Nucleonics* **12**, No. 2, 18-21 (1954) Feb.

Discrepancies between cavity-chamber and free-air measurements of  $Ra(B + C)$   $\gamma$  ray output are resolved by correcting for the chamber-wall density effect. The calculations presented for graphite can be applied to other wall materials. (C. H.)

2957

# LOGARITHMIC D-C RATEMETERS FOR SCINTILLATION COUNTERS. H. D. LeVine (New York Operations Office, AEC). *Nucleonics* **12**, No. 2, 36-9 (1954) Feb.

A logarithmic ratemeter circuit for use with scintillation counters is described and illustrated. It is said to be highly sensitive and to give good performance when used with portable instruments. Five or more decades can be covered without range switching by the ratemeter circuits

which utilize the logarithmic response characteristics of a subminiature triode. Advantage may be taken of triode photomultiplier characteristics for simple adjustment of mass-produced instruments to a standard calibration. (C.H.)

2958

GAMMA DOSE RATE FROM A Po-Be SOURCE. Gerald J. Rausa (Univ. of Rochester, N. Y.). *Nucleonics* 12, No. 2, 62 (1954) Feb.

The  $\gamma$  dose rate was calculated for a Po-Be source. Absorption curves made with an ionization chamber and absorbers of Pb and of paraffin are presented, and methods of obtaining the  $\gamma$  dose rate are discussed. (C.H.)

2959

RECENT ADVANCES IN THEORY OF SCINTILLATION PHOSPHORS. Robert K. Swank (Argonne National Lab., Lemont, Ill.). *Nucleonics* 12, No. 3, 14-19 (1954) Mar.

Theories of the mechanisms of scintillation processes in crystals, liquids, and solid solutions, and applications of scintillation counting as a standard technique for the measurement of ionizing radiations are reviewed. Topics discussed include energy transfer mechanisms, self-quenching, energy dependence, and the salient luminescent properties of the more important scintillators. The importance of the photomultiplier in making accurate measurements of decay time is stressed. (C. H.)

2960

AERIAL PROSPECTING WITH SCINTILLATION COUNTERS. G. Cowper (Atomic Energy of Canada, Ltd., Chalk River, Ontario). *Nucleonics* 12, No. 3, 29-32 (1954) Mar.

A system is described which utilizes scintillation counters for aerial prospecting. Two unshielded detectors and a ratemeter with cancellation circuit were used in conjunction with a continuously recording radioaltimeter, and a continuously running aerial camera. A coding system was used for synchronizing the three records. Results are reported for a field survey using the equipment. (C. H.)

2961

LARGE SCINTILLATORS, ČERENKOV COUNTERS FOR HIGH ENERGIES. Asher Kantz and Robert Hofstadter (Stanford Univ., Stanford, Calif.). *Nucleonics* 12, No. 3, 36-43 (1954) Mar.

Data on electron- and  $\gamma$ -induced showers in C, Al, Cu, Sn, and Pb are used to estimate the size of counter needed to obtain narrow pulse-height distributions in useful scintillation materials. The possibility of extending the total absorption spectrometer principles to high energies through the use of Čerenkov, or large-scale scintillation, counters is discussed. (C. H.)

2962

LARGE-VOLUME LIQUID SCINTILLATORS: THEIR APPLICATIONS. F. B. Harrison, C. L. Cowan, Jr., and F. Reines (Los Alamos Scientific Lab., N. Mex.). *Nucleonics* 12, No. 3, 44-7 (1954) Mar.

A 300-l scintillation counter is described which gives efficient detection of neutrons,  $\gamma$  rays, and lightly ionizing charged particles. The counter has been used for cosmic-ray measurements, neutrino detection, and determination of natural radioactivity in human beings. (C. H.)

2963

TOTAL-ABSORPTION X-RAY SPECTROMETER. H. W. Koch and R. S. Foote (National Bureau of Standards, Washington, D. C.). *Nucleonics* 12, No. 3, 51-3 (1954) Mar.

A NaI(Tl) scintillation spectrometer is described that can measure the energy of individual x-ray photons in the range from 0.5 to 50 Mev with an energy resolution better than 11% and a detection efficiency larger than 80%. General applications and applications of the spectrometer for betatron experiments are discussed. (C. H.)

2964

CHARACTERISTICS OF THE OPERATION OF METHYLAL-FILLED COUNTERS WITH AN EXTERNAL CATHODE. D. Blanc (Collège de France, Paris). *Nuovo cimento* (9) 11, 231-40 (1954) Mar. (In French)

Three series of counters, having an interior diameter of 1, 2, and 2.8 cm and filled with pure methylal, were tested under  $\gamma$  radiation. The starting threshold, the plateau threshold, and the maximum voltage of the plateau are linear functions of the methylal pressure up to the neighborhood of the maximum pressure in the case of the counter 1 cm in. diam. to 6 cm of Hg for the one 2 cm in. diam., and to 1.6 cm of Hg for the one 2.8 cm in. diam. In the present case, the pressure zones giving the best performances are 3.5 to 4.5 cm of Hg for the 1-cm counter, 2 to 4 cm of Hg for the 2-cm counter, and 1.5 to cm of Hg for the 2.8-cm counter. The efficiency is very near that obtained with the classic A-alcohol filled counter, and the operation is satisfactory for temperatures higher than 8°C. The values given are independent of the length as long as it is not less than 3 times the diameter. The counters of this type easily survive intense  $\gamma$  radiation; with the  $\gamma$  radiation of Cs, the effective rates of the classic type is 1.42/400,000 impulses/min. (tr-auth)

2965

VELOCITY OF DISCHARGE PROPAGATION IN SELF-QUENCHING GEIGER-MÜLLER COUNTERS. P. A. C. Mortier and J. F. Roose (Laboratorium voor Natuurkunde, Rijksuniversiteit, Ghent, Belgium). *Proc. Phys. Soc. (London)* A67, 161-3 (1954) Feb. 1.

Discharge propagation velocities were measured in Geiger counters 135 cm long with divided cathodes consisting of brass tubes (1 mm thick, internal diam. 22 mm) and a central anode of Mo wire of 0.08 mm diameter. The cathodes were carefully aligned and held at a mutual distance of  $\sim 0.2$  mm by means of Pyrex tubes sealed to the brass with araldite. The fillings consisted of specpure noble gases mixed with ethyl alcohol vapors. When the velocities of discharge propagation are plotted against overvoltage, the individual values spread somewhat more than can be accounted for by lack of perfect linearity of the time base. Results for the He-alcohol and A-alcohol mixtures are in good agreement with other published values, but references were not found for the other fillings. (L.M.T.)

2966

A FAST-COMPRESSION MAGNETIC CLOUD CHAMBER AND SOME AUXILIARY CONTROL CIRCUITS. C. R. Emigh (Univ. of Illinois, Urbana). *Rev. Sci. Instr.* 25, 221-5 (1954) Mar.

The primary considerations which were employed in the design of a cloud chamber for a recent experiment were to incorporate into its characteristics as high a magnetic field strength and as short a cycle time as practical, and a sequencing control circuit which would be both simple to adjust and reliable over long periods of data-taking time. A description is given of the important constructional details of the cloud chamber as well as a discussion of the more important auxiliary circuits. These are: the control circuits for the diesel-driven generator which supplies the current for the cloud-chamber field coils, the pulsed light system for photographic illumination, and the temperature regulating circuit for the cloud chamber. (auth)

2967

ON LIQUID ARGON IONIZATION CHAMBERS OF CENTIMETER SIZE. John H. Marshall (Massachusetts Inst. of Tech., Cambridge). *Rev. Sci. Instr.* 25, 232-7 (1954) Mar.

A parallel-plate chamber with electrode separation



variable from 2 mm to 2 cm has been used to measure recombination, attachment, and energy resolution for beta-ray ionization in liquid argon. A collecting voltage up to 30 kv was used without introducing spurious pulses. Amplifier noise sets the lower limit to beta-ray detection at about 150 kev and limits the energy resolution to about 100 kev (full width at half maximum at any energy). (auth)

2968

**ELECTRON TRANSIT TIMES IN GEIGER COUNTERS.** James R. Heirtzler (New York Univ.). *Rev. Sci. Instr.* **25**, 243-5(1954) Mar.

The transit time of an electron between the cylinder and the central wire of a self-quenching Geiger counter has been measured as a function of several counter parameters. The partial pressure, total pressure, and nature of the filling mixture were varied. The measured times are presented in graphic form. (auth)

2969

**A TRANSMISSION ČERENKOV COUNTER.** Seymour J. Lindenbaum (Brookhaven National Lab., Upton, New York) and Aihud Pevsner (Columbia Univ., New York). *Rev. Sci. Instr.* **25**, 285-6(1954) Mar.

A high efficiency transmission-transmission-type Cherenkov counter is described for use in counter telescope work. Range curves for liquids of different indices of refraction are presented. (auth)

2970

**A FAST NEUTRON SPECTROMETER.** J. R. Holt and A. E. Litherland (Univ. of Liverpool, England). *Rev. Sci. Instr.* **25**, 298(1954) Mar.

A spectrometer for neutrons of energies between about 5 and 25 Mev is described. Sensitivity and resolution have proved adequate for angular distribution work with deuteron stripping reactions. (L.M.T.)

2971

**ACTIVITY FROM A DISC-NEUTRON DETECTOR.** M. A. Vigon (Max Planck Institut für Physik, Göttingen, Germany). *Z. Naturforsch.* **8a**, 727-9(1953) Nov. (In German)

Bothe calculated the activity of a radioactive disk detector as a function of the neutron absorption coefficient  $\mu$  of the detector material for different self-absorption coefficients  $\alpha$  of the electron in the detector. The assumption  $\alpha/\mu \ll 1$  follows, in general, only in the presence of a strong resonance absorption of the detector for neutrons. In this work a general expression for the activity from the disk detector was derived as well as approximations for a single limiting case. It is shown that the activity with respect to the self-absorption of the electron depends on the orientation of the detector and that a consideration of these conditions allows a measurement, not only of the neutron density, but also of the neutron current. (tr-auth)

## MESONS

2972

**Rochester Univ.**  
 **$\pi^-$ -P INTERACTIONS AT 1.5 BEV.** J. Crussard, W. D. Walker, and M. Koshiba. Feb. 18, 1954. 7p. Contract AT(30-1)-875. (NYO-6229)

Stacks of 400- $\mu$  G-5 stripped emulsions were exposed to 1.5-bev  $\pi^-$  mesons, and  $\pi^-$ -proton interactions were studied. Angular distributions of proton,  $\pi^-$ , and  $\pi^0$  events are given. In elastic and  $\pi^0$  production cases, protons tend to go backward and  $\pi^-$  forward (c.m. system). Neutral and negative pions were found to have different angular distributions, with a tendency toward large angular separation. (K.S.)

2973

**Radiation Lab., Univ. of Calif., Berkeley**  
**MESONS PRODUCED IN PROTON-PROTON COLLISIONS.**

Vincent Peterson. May 22, 1950. 37p. Contract W-7405-eng-48. (UCRL-713)

An abstract of this report appears as UCRL-662 in NSA 4-4610.

2974

**Radiation Lab., Univ. of Calif., Berkeley**  
**MESON-MASS MEASUREMENTS. 2. ON THE MEASUREMENT OF THE MASSES OF CHARGED PIONS.** Frances M. Smith. Feb. 2, 1954. 42p. Contract W-7405-eng-48. (UCRL-2371)

The method developed and the results obtained in an extensive program of measurement of the masses of charged pions are presented. Measurements were made of the total ranges in nuclear track emulsion and the momenta (obtained from the curving of the particle trajectory in the magnetic field of the 184-inch cyclotron) of pions and protons of nearly the same velocity. This procedure eliminates any strong dependence on a range-momentum relationship for determining particle mass ratios. A beam of monoenergetic particles stopping in matter will have a distribution of ranges that is nearly Gaussian. Therefore the measurements in this study were treated statistically by introducing that function of the mass (the normalized range) which has a linear dependence on the range. The straggling theory was checked by examining the range distribution of monoenergetic muons. The distribution was found to be consistent with the theoretical expectations when allowance was made for several known sources of variance in addition to the so-called Bohr straggling. For a particle  $\beta$  of  $\approx 0.27$  the range straggling of muons in 200-micron C-2 emulsion is  $(4.5 \pm 0.1)\%$ , that of pions is  $(4.0 \pm 0.1)\%$ , and that of protons is  $(1.2 \pm 0.1)\%$ . A dependence of the apparent mass on the variable stopping power of the emulsion was eliminated from the mass ratio by taking the ratio of the expectation value of the normalized range of positive pions to that of protons. The apparent mass ratio was corrected for the small effect of the finite sizes of target and detector and for the so-called Lewis effect. The mean value of  $M$  (the true mass ratio) as found from six plates was  $0.14883 \pm 0.00016$ . In a second part of the study the ratio of the expectation value of the normalized range of negative pions to that of positive pions was found from three plates. The mean value of the true ratio of the mass of the negative to that of the positive pion was  $0.998 \pm 0.002$ . This ratio has been corrected for the small difference in stopping cross section to be expected for particles of opposite sign. (auth)

2975

**THEORY OF STRONG BOND.** B. T. Geylikman (Moscow State Pedagogical Inst. im Lenin, Russia). *Doklady Akad. Nauk S.S.S.R.* **91**, 39-42(1953) July 1. (In Russian) (cf. NSA 8-964)

The interaction of a pseudoscalar field with heavy particles of finite mass was investigated by applying Hamiltonian equations to the case of infinitely heavy particles. Computations of the motion of heavy particles were continued. (J.S.R.)

2976

**ON "AN UNUSUAL STAR" BY NAKAGAWA ET AL.** O. Minakawa and J. Nishimura (Kobe Univ., Japan). *J. Phys. Soc. Japan* **9**, 137-9(1954) Jan.-Feb.

The conclusions of Nakagawa (NSA 8-1660) are reviewed. Several factors are pointed out which lead to an interpretation of the star event as an interaction of a high-energy neutron. (K.S.)

2977

**REMARKS ON THE DECAY OF A MESON-ACTIVE TRITON.** A. Bonetti, R. Levi Setti, M. Panetti (Univ. of Milan, Italy),

L. Scarsi (Istituto Nazionale di Fisica Nucleare, Milan, Italy), and G. Tomasini (Univ. of Genoa, Italy). Nuovo cimento (9) 11, 330-1(1954) Mar. (In English)

The implication of the difference between the observed energy release observed by Bonetti et al. (Nuovo cimento 11, 210(1954) Feb.) and the  $Q$  value of the  $\Lambda^0$  observed by Crussard and Morellet (Compt. rend. 236, 64(1953)) was considered. The difference between the binding energy of the neutron and of the  $\Lambda^0$  in the triton is  $5.1 \pm 1.1$  Mev, giving a  $\Lambda^0$  binding energy of 1 Mev and a neutron binding energy of 6.24 Mev. (J.S.R.)

2978

THE MASS DIFFERENCE OF NEUTRAL AND NEGATIVE  $\pi$  MESONS. William Chinowsky and Jack Steinberger (Columbia Univ., New York). Phys. Rev. 93, 586-9(1954) Feb. 1.

The angular correlation of the decay  $\gamma$  rays from neutral  $\pi$  mesons produced in the reaction  $\pi^- + p \rightarrow n + \pi^0$  has been measured, using counter techniques. Analysis of the observed correlation function yields a value of the  $\pi^- - \pi^0$  mass difference  $m_{\pi^-} - m_{\pi^0} = 8.8 \pm 0.6 m_e$ . (auth)

2979

INELASTIC SCATTERING OF 220-Mev  $\pi^-$  MESONS IN EMULSIONS. W. F. Fry (Univ. of Wisconsin, Madison). Phys. Rev. 93, 845-7 (1954) Feb. 15.

The nuclear interaction of 220-Mev negative  $\pi$  mesons has been studied in photographic emulsions. A particular type of inelastic scattering events has been analyzed. Among 1960  $\pi^-$  meson interactions, 17 events are observed where the  $\pi$  meson transferred a large fraction of its initial energy to a single proton. The incident  $\pi$  meson, the scattered  $\pi$  meson, and the proton are nearly coplanar in most of these cases. However, the three tracks are not exactly coplanar, indicating that the meson collision was not with a hydrogen nucleus. The 17 events are interpreted as the interaction of the incident  $\pi$  meson with a single proton of the target nucleus. (auth)

2980

HIGH-ENERGY PROTONS IN NUCLEAR INTERACTION OF 220-Mev  $\pi^-$  MESONS IN NUCLEAR EMULSIONS. Gyo Takeda (Univ. of Wisconsin, Madison). Phys. Rev. 93, 848-50 (1954) Feb. 15.

The inelastic scattering of 220-Mev pions by a single collision with a nucleon in a nucleus is treated on the basis of the experimental pion-nucleon cross section. It is found possible to account in this way for the qualitative features of the events described in the preceding paper, if the effect of absorption of scattered pions and nucleons in the nucleus is included. (auth)

2981

INTERACTION OF PIONS WITH COMPLEX NUCLEI. Donald Harvey Stork (Univ. of California, Berkeley). Phys. Rev. 93, 868-80 (1954) Feb. 15.

Attenuation cross sections and cross sections for scattering into a fixed angular interval have been measured in a well defined geometry for pions of energies 33, 46, and 68 Mev. The targets were Be, C, Al, and Cu. The results were analyzed by means of the optical model, and a strong energy dependence was found for the pion interaction mean free path in nuclear matter. A satisfactory representation of this energy dependence is the equation  $\lambda_a/r_0 = [2b(kr_0)^4/\gamma^2]^{-1}$ , where  $\lambda_a$  is the mean free path,  $r_0$  is the pion Compton wavelength,  $b$  is a constant,  $k$  is the pion number, and  $\gamma$  is total pion energy divided by its rest energy. The results of an optical model calculation with the above energy dependence were compared with other published pion-nucleus data, and agreement was found. A partial wave analysis gave essentially the same results but required mean free paths about twice as long.

Published values of the pion-nucleon phase shifts at several energies were used to calculate the mean free path by means of multiple-scattering theory. The results agree with the above energy dependence and are intermediate between the mean free paths of the optical model and those of the partial wave analysis. (auth)

2982

PHOTOPRODUCTION OF  $\pi^+$  MESONS FROM HYDROGEN AND CARBON. G. Sargent Janes and William L. Kraushaar (Massachusetts Inst. of Tech., Cambridge). Phys. Rev. 93, 900-1 (1954) Feb. 15.

Experimental techniques are discussed and results are presented for the determination of  $\pi^+$ -meson photoproduction cross sections for H and C at a laboratory angle of  $90^\circ$ . In addition, the hydrogen  $\pi^+$  cross sections in the c.m. system are plotted against laboratory photon energy and against c.m. meson momentum. Mesons having energies down to 10 Mev were detected. (L.M.T.)

2983

ARTIFICIALLY PRODUCED NEGATIVE HEAVY MESON. J. Hornbostel and E. O. Salant (Brookhaven National Lab., Upton, N. Y.). Phys. Rev. 93, 902-3 (1954) Feb. 15.

A negative heavy meson (mass  $1050 \pm 150 m_e$ ) produced in the 2.2-bev proton bombardment of Be was observed in a stack of G5 Ilford emulsions after being deflected by the magnetic field of the Cosmotron. (L.M.T.)

2984

"V DINUCLEONS." H. Primakoff and W. Cheston (Washington Univ., St. Louis, and Univ. of Minnesota, Minneapolis). Phys. Rev. 93, 908-9 (1954) Feb. 15.

In a previous article (Phys. Rev. 93, 1537 (1953)) the authors suggested the possible existence of "V deuterons" of structure  $V^0 + p$  and their probable decay schemes. In this note an alternative structure of the V deuteron, namely  $V^+ + n$  is pointed out. In addition, particles which might be called "negative V deuterons," "V diprotons," and "V dineutrons" are postulated. (L.M.T.)

2985

RELATIVE INTENSITIES OF  $\pi$  AND  $\mu$  MESON X-RAYS OF THE K AND L SERIES IN LOW Z ELEMENTS. M. B. Stearns, S. DeBenedetti, M. Stearns, and L. Leipuner (Carnegie Inst. of Tech., Pittsburgh). Phys. Rev. 93, 1123-4(1954) Mar. 1.

Pulse-height distribution curves of x-ray emission resulting from  $\pi^-$  and  $\mu^-$ -meson capture in C and other elements are presented. Mesons from a 450-Mev synchrocyclotron are slowed by a Cu absorber and brought to rest in the target of the element investigated. The stopped mesons are detected with an anticoincidence telescope and the resultant x rays in a NaI counter. Results are also shown for the relative intensities of x rays as a function of Z. (L.M.T.)

2986

TOTAL CROSS SECTIONS OF 135-MEV TO 250-MEV NEGATIVE PIONS IN HYDROGEN. J. Ashkin, J. P. Blaser, F. Feiner, J. Gorman, and M. O. Stern (Carnegie Inst. of Tech., Pittsburgh). Phys. Rev. 93, 1129-30(1954). Mar. 1.

Measurements of the total cross section for the interaction of  $\pi^-$  mesons with protons at Chicago showed a rapid increase above 80 Mev with a leveling off or perhaps a maximum at 66.6 mb in the region 150 to 200 Mev. Brookhaven measurements above 265 Mev gave values well below the maximum Chicago value, thus confirming the existence of a maximum in the cross section in the Chicago energy range. The work reported in this note covers the energy range from below to above the maximum with the same technique, and by means of somewhat better accuracy permits the location of the cross section maximum within rather narrow limits. (L.M.T.)



2987

CHARGE INDEPENDENCE FOR V-PARTICLES. Tadao Nakano and Kazuhiko Nishijima (Osaka City Univ., Japan). *Progr. Theoret. Phys. (Japan)* **10**, 581-2(1953) Nov.

Consequences of assigning spin 1 to  $V_1$  particles and the assumption of charge independence are discussed. (K.S.)

## MICROWAVES

2988

SUBMILLIMETER WAVE SPECTROSCOPY. Charles A. Burrus and Walter Gordy (Duke Univ., Durham, N. C.). *Phys. Rev.* **93**, 897 (1954) Feb. 15.

An extension of microwave spectroscopy into the sub-millimeter wave region has been achieved. A spectrum line at 0.77-mm wavelength (389 kMc/sec) has been precisely measured with harmonics from a 5-Mc/sec marker monitored by the standard 5-Mc/sec signal broadcast by the National Bureau of Standards. This and other submillimeter waves lines of OCS which have been measured are listed. (auth)

## MOLECULAR PROPERTIES

2989

Solid-State and Molecular Theory Group, Mass. Inst. of Tech. QUARTERLY PROGRESS REPORT NO. 11. Jan. 15, 1954. 69p. Contract N5 ori-07856. (NP-5114)

A revised method for treating the difference equations encountered in the theory of perturbed wave functions of impurity levels in crystals has been developed. The procedure calls for an expansion of the function in terms of Bloch functions, with a subsequent transformation to Wannier functions. Further extensions are made to the three-dimensional impurity problem, introduced in the previous report. Preliminary calculations on convergence properties of the augmented plane wave method have been tested by application to the case of Cu and Na. A refined method for determining a good analytical fit for atomic self-consistent field representations is described, and work is under way, using the simplified technique, for extending the results to other ions and atoms. Valence bond structures for 4-electron square symmetry are reported. Solutions to a three-center spin-coupling problem are treated for the case of 2 paramagnetic ions with 1 electron, and 1 nonmagnetic ion with 2 electrons. Further investigations are reported on the suitability of one-electron functions for describing the polarization effects in KCl. General expressions are given for the expansion of products of spherical harmonics of degree 0 to 3, and specific form to all products of combined degree up to 6. Research on the thermal vibrations of Cu-Zn crystals continues in the direction of force-constant determinations. (For preceding period see NP-4702.) (K.S.)

## NEUTRONS

2990

A DETERMINATION OF THE ENERGY OF ANTIMONY-BERYLLIUM PHOTONEUTRONS. Richard Culp and Bernard Hamermesh (Argonne National Lab., Lemont, Ill.). *Phys. Rev.* **93**, 1025-8(1954) Mar. 1.

The effective energy of Sb-Be photoneutrons has been measured by comparison of the transmission cross sections of five elements for the photoneutrons with previously measured cross-section values over a range of energies. The result placed the energy close to 25 kev. (auth)

## NUCLEAR PHYSICS

2991

THE STRONG SURFACE COUPLING NUCLEAR MODEL AND HINDERED ALPHA DECAY. J. O. Rasmussen, Jr.

(Nobel Inst. of Physics, Stockholm). *Arkiv Fysik* **7**, 185-8 (1954).

It is suggested that nuclei whose magnetic moments lie near the opposite Schmidt limit from ordinary shell model predictions and which lie in regions of generally large nuclear spheroidal distortion (i.e., distant from closed shell neutron or proton numbers) may have predominantly strong-coupling configurations in the ground state with  $I < j$ . In the strong surface coupling approximation odd-nucleon nuclei situated in the same nucleon shell and having the same spin may have the odd nucleons in single particle orbitals of different nature, and this fact may have an important bearing on the alpha decay rate problem for odd nucleon types. (auth)

2992

ON SIMPLIFYING THE REDUCTION BY LEAST SQUARES OF ANGULAR DISTRIBUTION EXPERIMENTS IN NUCLEAR PHYSICS. P. C. Price (Cavendish Lab., Cambridge, England). *Phil. Mag.* (7) **45**, 237-45(1954). Mar.

The reduction of angular distribution experiments by the method of least squares is often very laborious. An experimental procedure is described which simplifies the computations by using a particular set of experimental angles and of relative weights of the observations at each angle. The method of calculation is an application of Gauss' Formula of Numerical Integration; a proof that this method is a 'least squares' reduction is given in an Appendix. Four-figure tables are included to facilitate the use of the method. (auth)

2993

COULOMB EXCITATION OF HEAVY AND MEDIUM HEAVY NUCLEI BY ALPHA PARTICLES. G. M. Temmer and N. P. Heydenburg (Carnegie Institution of Washington, D. C.) *Phys. Rev.* **93**, 351-3(1954) Jan. 15.

Preliminary results on the Coulomb excitation of 35 nuclei ( $20 \leq Z \leq 90$ ) by protons and  $\alpha$  particles of energies up to 3.8 Mev are reported. (K.S.)

2994

$\mu$ -MESON DECAY,  $\beta$  RADIOACTIVITY, AND UNIVERSAL FERMI INTERACTION. L. Michel (Inst. for Advanced Study, Princeton, N. J.) and A. Wightman (Princeton Univ., N. J.). *Phys. Rev.* **93**, 354-5(1954) Jan. 15.

It is shown that data on  $\mu$  and  $\beta$  decay can be reconciled with a universal Fermi interaction and that other frequently proposed interactions are excluded. (K.S.)

2995

COULOMB CORRECTIONS IN STRIPPING. S. T. Butler and N. Austern (Cornell Univ., Ithaca, N. Y.). *Phys. Rev.* **93**, 355(1954) Jan. 15.

An investigation of the influence of Coulomb forces on the deuteron stripping reaction is reported for the capture of 1 = 2 protons, using an 8-Mev deuteron beam incident on a nucleus of  $Z \approx 15$ . The angular distribution obtained was found to closely fit non-Coulomb results in a region where large Coulomb changes were anticipated. (K.S.)

2996

TRANSIENT NUCLEAR INDUCTION SIGNALS ASSOCIATED WITH PURE QUADRUPOLE INTERACTIONS. M. Bloom and R. E. Norberg (Univ. of Illinois, Urbana). *Phys. Rev.* **93**, 638-9(1954) Feb. 1.

Transient "pure quadrupole" induction signals corresponding to the "Bloch decays" and echoes found in pulsed nuclear magnetic resonance experiments were observed. The induction signals arise from oscillating components of magnetization established along the axis of the applied rf magnetic field  $H_1$ . A quantum-mechanical calculation predicted that these transient components should occur even though, at equilibrium, the electric interaction  $Q \cdot \nabla E$  produces no macroscopic magnetization. (auth)

2997

ANISOTROPIC RELAXATION OF QUADRUPOLE SPIN ECHOES. E. L. Hahn and B. Herzog (Columbia Univ., New York). *Phys. Rev.* **93**, 639-40 (1954) Feb. 1.

The free Larmor precession of  $\text{Cl}^{35}$  and  $\text{Cl}^{37}$  nuclear moments, due only to the pure crystalline electric field gradient in single and powdered crystals of  $\text{NaClO}_3$ , were observed by the pulsed nuclear induction method. When a small constant magnetic field  $H_0$  is applied to the single crystal, the echo relaxation time due to spin-spin coupling is modified by the variation of the Zeeman splitting as the magnitude and direction of  $H_0$  normal to the cubic axis of a  $\text{NaClO}_3$  single crystal is varied. (auth)

2998

COULOMB EXCITATION OF HEAVY AND MEDIUM HEAVY NUCLEI BY ALPHA PARTICLES. II. N. P. Heydenburg and G. M. Temmer (Carnegie Institution of Washington, D. C.). *Phys. Rev.* **93**, 906-7 (1954) Feb. 15.

In a previous article (*Phys. Rev.* **93**, 351 (1954)) the authors presented a partial list of low-lying excited states in several nuclei resulting from 3-Mev  $\alpha$ -particle Coulomb excitation. In this note the list is supplemented and a discussion is presented of criteria to be used in evaluating the results. The preliminary conclusions to date are summarized. (auth)

2999

THEORY OF BREMSSTRAHLUNG AND PAIR PRODUCTION. I. DIFFERENTIAL CROSS SECTION. H. A. Bethe and L. C. Maximon (Cornell Univ. Ithaca, N. Y.). *Phys. Rev.* **93**, 768-84 (1954) Feb. 15.

The differential cross sections for bremsstrahlung and pair production are calculated without the use of the Born approximation assuming the energy of the electron to be large compared to  $mc^2$  both in initial and final state. The wave functions in initial and final state are essentially those previously proposed by Furry. It is proved that the wave functions agree with the exact ones of Darwin except for terms of relative order  $a^2/l^2$ , where  $a = Ze^2/\hbar c$  and  $l$  the angular momentum, and that this agreement holds for any energy of the electron. An independent proof is given, showing that the Furry wave functions give the matrix element correctly except for terms of relative order  $1/\epsilon$ . In the matrix element for bremsstrahlung, the initial state of the electron must be represented by a plane wave plus an outgoing spherical wave, whereas the final state has an ingoing spherical wave. In pair production, both electrons contain ingoing spherical waves. This causes essential differences between the cross sections for the two processes. The cross section for pair production is calculated; the result consists of the Bethe-Heitler formula multiplied by a relatively simple factor, plus another term of similar structure. A simplified derivation is given, which is valid for the important case of small angles between electrons and quantum. The bremsstrahlung cross section is calculated and found to be the Bethe-Heitler result multiplied by a factor. This factor is different from that encountered in pair production and becomes important only for very small momentum transfer  $q$ . In the limit of complete screening, these small  $q$  do not contribute and the cross section goes over into that of the Born approximation. The error in the cross sections calculated in this paper is estimated to be of order  $1/\epsilon$ , where  $\epsilon$  is the energy of the final electron in bremsstrahlung, or that of the less energetic electron in pair production, in units of  $mc^2$ . The total cross section for pair production by a quantum of energy  $k$  may be in error by  $\log k/k$ . (auth)

3000

THEORY OF BREMSSTRAHLUNG AND PAIR PRODUCTION. II. INTEGRAL CROSS SECTION FOR PAIR PRODUCTION.

Handel Davies, H. A. Bethe, and L. C. Maximon (Cornell Univ., Ithaca, N. Y.). *Phys. Rev.* **93**, 788-95 (1954) Feb. 15.

The differential cross section for bremsstrahlung and pair production at high energies, obtained in the preceding paper by Bethe and Maximon, has been integrated over all angles, and formulas are given for the integral cross section for all  $Z$ . For small  $Z$ , the correction to the Born approximation is proportional to  $Z^2$ , and the constant of proportionality is given. The correction for heavier elements is somewhat less than the  $Z^2$  law would indicate. It is shown that the correction is associated only with large recoil momenta of the nucleus, whereas screening is important only for small recoil momenta; and, therefore, the same correction is valid in the case of complete, incomplete, or no screening. Agreement of these new predictions with observations of pair-production cross section at 88 and 280 Mev is excellent and not unreasonable at 17.6 Mev. (auth)

3001

REDUCTION OF AN INTEGRAL IN THE THEORY OF BREMSSTRAHLUNG. A. Nordsieck (Univ. of Ill., Urbana). *Phys. Rev.* **93**, 785-7 (1954) Feb. 15.

A matrix element integral for bremsstrahlung or pair production without Born approximation is reduced to an ordinary hypergeometric function by contour integration methods. The result is stated for bremsstrahlung and for pair production. (auth)

3002

PHOTODISINTEGRATION OF THE DEUTERON BY 180-Mev AND 260-Mev GAMMA RAYS. J. Keck, R. M. Littauer, G. K. O'Neill, A. M. Perry, and W. M. Woodward (Cornell Univ., Ithaca, N. Y.). *Phys. Rev.* **93**, 827-8 (1954) Feb. 15.

The photodisintegration of the deuteron is observed at  $\gamma$ -ray energies of 180 and 260 Mev. Both a low-temperature compressed-gas target and a  $\text{D}_2\text{O}-\text{H}_2\text{O}$  subtraction method are used. The photoprotons are detected in a crystal counter telescope. Their angular distribution shows a fairly marked forward asymmetry. The total cross sections at 165 and 230 Mev (c.m.) are 54 and 66  $\mu\text{b}$ , respectively, with an estimated error of 10% on the absolute scale. (auth)

3003

THEORY OF NUCLEAR LEVEL DENSITY. Claude Bloch (California Inst. of Tech., Pasadena). *Phys. Rev.* **93**, 1094-1106 (1954) Mar. 1.

We have compared the level density of a nuclear model deduced from a statistical analysis with the results of the exact counting of the levels of the same model. The tables of levels of  $\text{Ne}^{20}$  given by Critchfield and Oleksa have been used as a test of the statistical theory. A new derivation of the level density is presented. It starts, as usual, from the independent-particle model. However, it differs from the previous treatments in two respects: (a) the exact states of the nucleons in the central potential are kept throughout the calculations instead of being replaced by a continuous distribution; (b) the effect of mutual interactions of the nucleons of the Majorana, Bartlett, or Heisenberg type is taken into account in the long-range approximation. With these modifications, the statistical theory agrees very well with the exact counting of the levels, both for the total density and for the density of the levels having a given angular momentum. It is shown that the replacement of the nucleon states by a continuous distribution introduced in most previous derivations, and the neglect of the Majorana forces can produce very large errors. An interpretation is presented of the distribution of angular momentum among nuclear levels in terms of rotations of the whole nucleus as a rigid body. (auth)



3004

STUDIES IN INTERMEDIATE COUPLING—II: RADIATIVE TRANSITIONS IN LIGHT NUCLEI. A. M. Lane and L. A. Radicati (Univ. of Birmingham, England). *Proc. Phys. Soc. (London)* **A67**, 167-80(1954) Feb. 1.

Formulae are presented for the matrix elements of the various types of radiative transitions of low multipolarity that are frequently met in light nuclei. These formulae are derived on the basis of the nuclear shell-model. First of all, extreme L-S coupling and extreme j-j coupling are considered with a view to seeing if either can give an adequate account of the experimental data. It is found, in fact, that neither extreme mode of coupling can do this, but that an intermediate coupling probably could. As an example, the radiative transitions in  $N^{13}$  are studied in detail in intermediate coupling and are found to give considerable support to this contention. (auth)

# NUCLEAR PROPERTIES

3005

Wesleyan Univ.

A NEW MEASUREMENT OF THE  $Pt^{195}-Cu^{65}$  PACKING FRACTION DIFFERENCE. Henry E. Duckworth. [Sept. 27, 1949]. 4p. (AECU-414; WU-4)

3006

Los Alamos Scientific Lab.

MU-MESONIC X-RAYS AND THE SHAPE OF THE NUCLEAR CHARGE DISTRIBUTION. David L. Hill, Los Alamos Scientific Lab. and Kenneth W. Ford, Indiana Univ. [1954] 50p. Contract [W-7405-eng-36]. (AECU-2820)

The dependence of the  $\mu$ -mesonic  $\pi$ -ray spectrum of Pb on the extent and shape of the nuclear charge density is reported. For several functional families representing conceivable forms for  $\rho(r)$  the resultant Coulomb potentials have been obtained, and the relativistic equations have been solved to yield the first four levels (1S, 2S, and 2P) and transition energies for  $\mu$  mesons bound in the field of the Pb nucleus. The next two levels (3D) have been found by perturbation theory. Effects omitted from the calculations have been examined, and theoretical uncertainties estimated for each level. These results permit adjustment of the effective electric radius R for each form of  $\rho(r)$ , to agree with known x-ray measurements of the  $2P \rightarrow 1S$  transitions. Calculations completed for neighboring values of R permit interpolation to improved values when more precise measurements are made and when small corrections of the raw data for electrodynamic and special coupling effects have been carried through. The doublet splitting of the 2P levels offers an independent measure of R, as well as a check on the possible existence of an anomalous muon magnetic moment. In contrast, the  $3D \rightarrow 2P$  and  $2S \rightarrow 2P$  transition energies are insensitive to R but sufficiently sensitive to the shape of the charge distribution, so that accurate measurements of the transition energies between the six lowest muon levels in the heavy nuclides will provide knowledge of both the electric radius and the shape of nuclear electrification, independently of indications from the other phenomena mentioned above. (auth)

3007

Atomic Energy Research Establishment, Harwell, Berks (England)

THE REDUCED WIDTHS OF NUCLEAR ENERGY LEVELS. A. M. Lane. Jan. 1954. 62p. (AERE-T/R-1289)

Using the nuclear shell model, theoretical formulas are derived for the reduced widths of energy levels in L-S and in j-j coupling. These formulas are used to make predictions about the reduced widths for nucleon emission of levels in

the 1p shell, and the results are compared with those obtained experimentally. (auth)

3008

THE NON-EXISTENCE OF ISOMERISM IN BROMINE 82. [Sur la Non-Existence d'une Isomerie du brome 82].

Andre Berthelot, Lily Papineau, and Christiane Herczeg. Translated from *Compt. rend.* **232**, 498-9(1951). 3p. (AEC-tr-1839)

An abstract of this paper appears in *Nuclear Science Abstracts* as NSA 5-2573.

3009

SPINS, MAGNETIC MOMENTS AND NUCLEAR STRUCTURE. [Spins, Moments Magnetiques et Structure Nucleaire.].

G. J. Bene, P. M. Denis, and R. C. Extermann. Translated from *Helv. Phys. Acta* **22**, 606-9(1949). 4p. (AEC-tr-1846)

An abstract of this paper appears in *Nuclear Science Abstracts* as NSA 4-1535.

3010

THE ANGULAR CORRELATION OF  $Ni^{60}$ . T. Wiedling (Univ. of Stockholm). *Arkiv Fysik* **7**, 69-71(1954).

The angular correlation of  $Ni^{60}$  was remeasured using scintillation counters with E.M.I. 5311 multipliers and NaI crystals. The anisotropy found after all corrections

was  $\frac{W(\pi)}{W(\pi/2)} - 1 = 0.155$  using Church and Kraushaar's

correction formulas and  $\frac{W(\pi)}{W(\pi/2)} - 1 = 0.162$  using Walter's

correction formula. The discrepancies between these measurements and others indicate a need for a new and more accurate investigation. (J.S.R.)

3011

RADIOACTIVITY AND THE SHELL MODEL. S. C. Curran (Univ. of Glasgow, Scotland). *Atomica* **5**, 46-54(1954) Feb.

A review is given of the possible correlation of radioactivity and the nuclear shell model. The scheme of the shell model is tabulated. A brief outline of nuclear spectroscopy is presented. The major application of the shell model up to the present is found in the simplification of  $\beta$  transitions according to ft value. General properties related to shell structure, modifications of the model, and energetics of  $\beta$  decay are briefly discussed. The decay of  $Rb^{87}$  to  $Sr^{87}$  and of  $Hg^{203}$  to  $Tl^{203}$  are given as examples of the applicability of the nuclear shell model. (J.S.R.)

3012

PROPORTIONAL COUNTER MEASUREMENT OF THE RATIO L CAPTURE/K CAPTURE BY  $Kr^{79}$ . Mickel Langevin and Pierre Radvanyi. *Compt. rend.* **238**, 77-80(1954) Jan. 4. (In French)

The ratio of L capture to K capture by  $Kr^{79}$  was measured by introducing the Kr as a gaseous source into a proportional counter filled with propane. The value  $\lambda_L/\lambda_K = 0.25 \pm 0.03$ , which confirms previous measurements made with a Wilson cloud chamber, disagrees with the theoretical predictions. (tr-auth)

3013

ON THE COUPLING BETWEEN THE ODD PROTON AND NEUTRONS IN  $Cu^{63}$  AND  $Cu^{65}$ . M. Trocheris. *J. phys. Radium* **14**, 635-6(1953) Nov. (In French)

The interaction of a single nucleon of an odd-even nucleus with incomplete shells containing even numbers of nucleons is treated within the limits of the Bohr model. The incomplete shells are replaced by an oscillating surface. All other nucleons are considered to interact with this surface according to the Pauli principle. (tr-auth)

3014

MEASUREMENT OF THE TOTAL CROSS SECTION FOR SLOW NEUTRONS. E. Gatti, E. Germagnoli, and G. Perona (Laboratori CISE, Milan, Italy). *Nuovo cimento* (9) **11**, 262-73(1954) Mar. (In Italian)

The energy dependence of the total cross sections for slow neutrons of uranium, nickel, and cadmium has been investigated with the transmission method by means of a time-of-flight spectrometer and of a pulsed neutron source. (auth)

3015

**Tensor Force and Intermediate Coupling in P-Shell Nuclei.** T. Regge (Univ. of Turin, Italy). *Nuovo cimento* (9) 11, 285-91(1954) Mar. (In Italian)

Using the shell model, the splitting among the levels of light nuclei with 6 or 14 nucleons was evaluated. The introduced interactions are the spin-orbit couplings of every nucleon in the field of the residual nucleus, the central force, and the tensor force between the external nucleons in order to calculate the influence of the last one on the order and the distance of the levels. The results obtained show that at least in this particular case this influence is not negligible. To compare the deductions with those of Inglis (who used only central forces) it may be said that in the case considered the introduction of these new kinds of interactions does not lead to a better agreement with experiment. (auth)

3016

**The Anomalous Spin of  $^{47}\text{Ti}$ .** B. H. Flowers (Atomic Energy Research Establishment, Harwell, Berks, England). *Phil. Mag.* (7) 45, 329-32(1954). Mar.

A general discussion is given of the occurrence of anomalous spins among the odd mass nuclei. It is shown that the spin of  $\text{Ti}^{47}$  may be understood on the basis of the independent particle model provided proper account is taken of the charge independence of nuclear forces.  $V^{49}$  is predicted to have spin  $5/2$ . (auth)

3017

**Absorption Cross Sections for 134 Mev Protons.** J. M. Cassels and J. D. Lawson (Atomic Energy Research Establishment, Harwell, Didcot, Berks, England). *Proc. Phys. Soc. (London)* A67, 125-33(1954) Feb. 1.

The absorption cross sections for 134 Mev protons of carbon, aluminum, copper, cadmium, and lead have been measured by a transmission method. The results are consistent with the predictions of the usual optical theory for high-energy nuclear cross sections. (auth)

3018

**The Energies of Excited States of Nuclei.** G. E. Tauber and Ta-You Wu (National Research Council, Ottawa, Canada). *Phys. Rev.* 93, 434-6 (1954) Feb. 1.

A search for equal ratios of energies in even-even isotope nuclei observed by Redlich has been extended to even-even isotone and even-odd, odd-even isotope and isotone nuclei. It is found that on the basis of the existing data, a similar regularity does not seem to be present in these groups of nuclei. (auth)

3019

**Isotopic Spin and Odd-Odd  $N = Z$  Nuclei.** S. A. Moszkowski and D. C. Peaslee (Columbia Univ., New York). *Phys. Rev.* 93, 455-8 (1954) Feb. 1.

The lowest-lying states of isotopic spin  $T = 0$  and  $T = 1$  are surveyed for odd-odd nuclei with  $N = Z$  by considering  $\beta$ -decay schemes and Coulomb energy differences. For  $A \geq 26$  the lowest  $T = 0$  and  $T = 1$  states appear to be very close together. The analysis permits certain predictions regarding the decay schemes of these nuclei. Further experimental information is needed on the higher members of this series, from  $\text{Sc}^{42}$  to  $\text{Cu}^{68}$ . Predicted  $\beta$ -decay schemes for some corresponding  $Z = N + 2$  nuclei are also summarized. (auth)

3020

**Nuclear Quadrupole Resonance of  $\text{Hg}^{201}$ .** H. G. Dehmelt, H. G. Robinson, and Walter Gordy (Duke Univ.,

Durham, N. C.). *Phys. Rev.* 93, 480-2 (1954) Feb. 1.

Five nuclear quadrupole resonance lines have been observed in polycrystalline  $\text{HgCl}_2$ . From their frequencies, the magnitudes of the quadrupole coupling constants  $eQq_{zz}(\text{Hg}^{201}) = 720 \text{ Mc/sec}$  and  $eQq_{zz}(\text{Cl}^{35}) = 44.3 \text{ Mc/sec}$  were evaluated. Comparison of the  $\text{Cl}^{35}$  coupling constant in  $\text{HgCl}_2$  with that known for the free Cl atom from atomic beam experiments facilitates the discussion of the molecular structure. A quadrupole coupling constant of 1000 Mc/sec per p electron in the 6s6p configuration of free Hg is deduced from the  $\text{Hg}^{201}$  coupling in  $\text{HgCl}_2$ . This value can be directly compared with the coupling of the 6s6p,  $^2P_2$  HgI term,  $eQq_{zz}(\text{Hg}^{201}, p_z) = 780 \text{ Mc/sec}$ , which is equivalent to the value of the quadrupole parameter  $B = 0.27 \times 10^{-3} \text{ cm}^{-1}$  known from optical hfs investigations. Whereas a standard analysis of the hfs of the  $^2P_2$  term had given  $Q(\text{Hg}^{201}) = 0.5 \times 10^{-24} \text{ cm}^2$ , a discrepant value  $Q(\text{Hg}^{201}) = 0.2 \times 10^{-24} \text{ cm}^2$  was obtained from the  $^1P_1$  term. The results yield a value  $0.6 \times 10^{-24} \text{ cm}^2$ , in fair agreement with the larger value found for the  $^2P_2$  term. (auth)

3021

**The Branching Ratio of  $\text{K}^{40}$ .** G. J. Wasserburg (Univ. of Chicago) and R. J. Hayden (Argonne National Lab., Lemont, Ill.). *Phys. Rev.* 93, 645-6(1954) Feb. 1.

In view of certain discrepancies, a redetermination was made of the  $A^{40}/K^{40}$  ratio in a sample of K feldspar utilizing isotopic dilution techniques. When the age uncertainties of the samples are considered, the results are essentially in agreement a value of 0.13 for the  $\text{K}^{40}$  branching ratio as determined by Inghram, et al. (*Phys. Rev.* 80, 916(1950)). (L.M.T.)

3022

**Nuclear Quadrupole Coupling in Polar Molecules.** H. M. Foley (Columbia Univ., New York), R. M. Sternheimer (Brookhaven National Lab., Upton, N. Y.), and D. Tycko (Columbia Univ., New York). *Phys. Rev.* 93, 734-42 (1954) Feb. 15.

The effect of an external charge on the nuclear electric quadrupole coupling has been investigated for various ions. These results presumably apply to the case of polar molecules. The quadrupole moment induced by the nuclear quadrupole moment  $Q$  is  $46.5Q$ ,  $8.7Q$ ,  $50.2Q$ , and  $86.8Q$  for the  $\text{Cl}^-$ ,  $\text{Cu}^+$ ,  $\text{Rb}^+$ , and  $\text{Cs}^+$  ions, respectively. When an external charge interacts with the ion as in a polar molecule, the induced moment is added to  $Q$ , so that the quadrupole coupling is multiplied by a factor of order 10 to 100. This model of a polar molecule disregards the exchange repulsion between the ions. Evidence is presented from several molecules which seems to confirm the existence of the induced quadrupole moment, although there is only partial agreement with the experimental values. It is shown that the contribution to the quadrupole coupling due to the induced dipole moment in second order is small compared to the induced quadrupole effect. (auth)

3023

**The Nuclear Magnetic Moments of  $\text{Xe}^{129}$  and  $\text{Xe}^{131}$ .** E. Brun, J. Oeser, H. H. Staub, and C. G. Telschow (Zürich Univ., Switzerland). *Phys. Rev.* 93, 904 (1954) Feb. 15.

The nuclear magnetic resonances of  $\text{Xe}^{129}$  and  $\text{Xe}^{131}$  in pure Xe gas at  $\sim 50$  atmos were detected with a nuclear induction spectrometer similar to the one described by Weaver (*Phys. Rev.* 89, 923 (1953)). The magnetic moment values obtained (without diamagnetic corrections) are  $\mu_{129} = -0.77255 \pm 0.00002 \text{ nm}$  and  $\mu_{131} = +0.68680 \pm 0.00002 \text{ nm}$ . (L.M.T.)

3024

**The Half-Life of Yttrium-90.** A. Chetham-Strode



Jr., and E. M. Kinderman (Hanford Works, Richland, Wash.). *Phys. Rev.* **93**, 1029(1954) Mar. 1.

Radioactive  $Y^{90}$  separated from two aged samples of fission product strontium was allowed to decay. The change in activity was followed for more than 650 hours with standard mica-window beta counters. From the observed changes, the mean half life of  $Y^{90}$  was calculated to be  $64.60 \pm 0.43$  hours. (auth)

3025

SLOW NEUTRON RESONANCES IN CESIUM, PALLADIUM, AND GOLD. H. H. Landon and V. L. Sailor (Brookhaven National Lab., Upton, N. Y.). *Phys. Rev.* **93**, 1030-3(1954) Mar. 1.

The slow neutron total cross sections of Cs, Pd, and Au have been measured with a crystal spectrometer using Be as a monochromator. A strong resonance was found in Cs at 5.90 ev. The strength of this resonance is  $\sigma_0 \Gamma^2 = 144 \pm 25$  barn  $\text{ev}^2$  with  $\sigma_0 = 9500 \pm 2000$  barns. Pd has a strong resonance at 34.1 ev with weaker ones at 26 and 13.3 ev. The 4.91-ev resonance in Au has been found to have unusual shape. If it is a single resonance, the maximum total cross sections is  $\sigma_0 = 31,000 \pm 1000$  barns and the total width is  $\Gamma = 0.175 \pm 0.01$  ev. (auth)

3026

THE INTERNAL CONVERSION COEFFICIENTS OF  $Nb^{95}$ ,  $Zn^{65}$ , AND  $Sc^{46}$ . E. F. Sturcken, Z. O'Friel, and A. H. Weber (St. Louis Univ., Missouri). *Phys. Rev.* **93**, 1053-6 (1954) Mar. 1.

The theory of nuclear  $\gamma$ -ray yield determination from Compton electron spectra has been recently developed by Thomas and Lauritsen for interpretation of electron spectra from photoelectric and Compton conversion processes observed with a magnetic lens  $\beta$ -ray spectrometer. The total internal conversion coefficient ( $N_e/N_\gamma$ ) is measured by determining  $N_\gamma$  from a high-energy segment of the Compton electron spectrum observed from a thick ( $140\text{-mg/cm}^2$ ) aluminum converter and  $N_e$  from the internal conversion spectrum of the same source observed without a radiator. The total internal conversion coefficients of two of the isotopes,  $Mo^{95}$  (parent,  $Nb^{95}$ ) and  $Ti^{46}$  (parent,  $Sc^{46}$ ), were also determined by the direct comparison of areas under their internal conversion and beta-spectrum curves and so permitted a check of the new method. The results of the two methods of determination of  $\Gamma$  are in satisfactory agreement with each other, with other experimental values, and with the predictions of Rose's tables. The results are as follows.  $Mo^{95}$  (parent,  $Nb^{95}$ )  $E_\gamma = 0.77$  Mev: by the areas-under-curves method  $\Gamma = (2.05 \pm 0.13) \times 10^{-3}$ , by the thick-converter Thomas-Lauritsen method  $\Gamma = (1.74 \pm 0.24) \times 10^{-3}$ .  $Ti^{46}$  (parent,  $Sc^{46}$ )  $E_\gamma = 1.12$  Mev: by the areas-under-curves method  $\Gamma = (1.34 \pm 0.15) \times 10^{-4}$ , by the Thomas-Lauritsen method  $\Gamma = (1.00 \pm 0.06) \times 10^{-4}$ .  $Ti^{46}$  (parent,  $Sc^{46}$ )  $E_\gamma = 0.89$  Mev: by the areas-under-curves method  $\Gamma = (2.60 \pm 0.50) \times 10^{-4}$ , by the Thomas-Lauritsen method  $\Gamma = (1.86 \pm 0.25) \times 10^{-4}$ .  $Cu^{65}$  (parent,  $Zn^{65}$ )  $E_\gamma = 1.112$  Mev: by the Thomas-Lauritsen method  $\Gamma = (2.20 \pm 0.37) \times 10^{-4}$ . (auth)

0027

MAGNETIC MOMENT OF THE FIRST EXCITED STATE OF  $Pb^{204}$ . H. Frauenfelder, J. S. Lawson, Jr., and W. Jentschke (Univ. of Illinois, Urbana). *Phys. Rev.* **93**, 1126-7(1953). Mar. 1.

The anisotropy of the  $Pb^{204}$   $\gamma$ - $\gamma$  cascade was measured as a function of the external magnetic field strength applied perpendicular to the plane of the two coincidence counters. The correlation function at the angles 75, 105, 140, 180, and 220° was then measured for two different field strengths. The g factor was calculated by means of the experimental

data and the theoretical expression for the delayed correlation function of Biedenharn and Rose (Revs. Mod. Phys. **25**, 729(1953)). A value of g ( $Pb^{204}$ , first-excited state) =  $+(0.07_{-1.03}^{+0.06})$  was determined. With the known spin of 2 for the first excited state, the magnetic moment becomes  $\mu = \pm(0.14_{-0.06}^{+0.12})\mu_N$ . The small magnetic moment supports Bohr and Mottelson's supposition that the  $2^+$  state in  $Pb^{204}$  is not a rotational state. (L.M.T.)

3028

NOTE ON A j-j COUPLING SHELL MODEL. Minoru Umezawa (Tokyo Univ., Japan). *Progr. Theoret. Phys. (Japan)* **10**, 505-8(1953) Nov.

Magnetic moments of two odd-odd nuclei, first excited states of light nuclei, and nuclear quadrupole moments are treated from the standpoint of the charge symmetric j-j coupling shell model. It is shown that the theoretical magnetic moments calculated according to the assumption given previously are consistent with the experimental magnetic moments. However, the quadrupole moments of middle and heavy nuclei might not be explainable by j-j coupling of nucleons in nuclei. (auth)

3029

UPPER BOUND OF THE PSEUDOSCALAR COUPLING CONSTANT IN BETA-DECAY. Jun-ichi Fujita and Masami Yamada (Univ. of Tokyo, Japan). *Progr. Theoret. Phys. (Japan)* **10**, 518-24(1953) Nov.

The allowed-shape  $\beta$  spectra of  $He^6$  and  $B^{12}$  are investigated with a mixture of tensor and pseudoscalar interactions, and it is concluded that the ratio of the pseudoscalar coupling constant to that of tensor must lie in the region  $-55 < G_P/G_T < 19$ . (auth)

3030

THE ELECTRON RADIATION OF ISOMERIC NUCLEI WITH AN UNEVEN NEUTRON NUMBER. Berthold Stech (Univ. of Heidelberg, Germany). *Z. Naturforsch.* **9a**, 1-4 (1954) Jan. (In German)

Nuclei with uneven neutron numbers can lose their excitation energy even in the vigorous single-particle model during emission of electrical multipolar radiation. The emission is possible through a relativistic term which comes from the magnetic moment of neutrons. Its calculation leads to approximate agreement with the experimental data. A clear derivation of the formula for the magnetic multipolar radiation is given. (tr-auth)

#### NUCLEAR REACTORS

3031

Joint Establishment for Nuclear Energy Research (Norway) PROCEEDINGS OF THE KJELLER CONFERENCE ON HEAVY WATER REACTORS, HELD AT KJELLER AND OSLO, AUGUST 11 TO 13, 1953. J. A. Goedkoop and G. Jenssen, eds. 1953. 249p. (JENER-Pub-7)

A collection of papers is presented on  $D_2O$  reactors and the associated problems connected with the application of such reactors to industrial power production. Several well-known operational reactors are discussed, together with instrumentation and control techniques. Generalized topics on reactor design and theory are included. (K.S.)

\*3032

Oak Ridge National Lab. DETERMINATION OF THE POWER OF THE BULK SHIELDING REACTOR. PART 3. MEASUREMENT OF THE ENERGY RELEASED PER FISSION. J. L. Meem, L. B. Holland, and G. M. McCammon. Mar. 11, 1954. 88p. Contract W-7405-eng-26. (ORNL-1537)

The energy released per fission was measured in the Bulk Shielding Reactor using a specially constructed fuel element. The special element had a removable center fuel

plate from which discs were punched to facilitate measurement of their activation by exposure in the reactor. A similar U-bearing disc was activated by exposure in a known neutron flux. By comparison, the actual fission rate in the special fuel element was determined. The special element was equipped with water tubes at top and bottom through which water was pumped at a known rate. Thermocouples were used to measure the temperature rise across the fuel element, special precautions being taken to prevent heat leakage. The power, or rate of energy production, was determined from the water flow and temperature rise, and a comparison with the fission rate gave the heat released per fission in the special element. The net amount of radiation leaking out of the fuel element (less than 0.2%) was calculated as a correction to this figure. The energy per fission in the reactor was  $193 \pm 5$  Mev. The parasitic capture in the Bulk Shielding Reactor is calculated to be 2.7 Mev. Accordingly, the energy released per fission (exclusive of neutrino energy) is  $190 \pm 5$  Mev. (auth)

3033

PHOTONEUTRONS IN A HEAVY WATER PILE. M. W. Johns and B. W. Sargent (Atomic Energy of Canada, Ltd., Chalk River). *Can. J. Phys.* 32, 136-52 (1954) Feb.

Decay curves of the neutron intensity in the low power heavy water pile (ZEEP) at Chalk River as a function of time from shutdown with cadmium rods were obtained with three proportional counters of different sensitivities. The range of counting rates spanned, including operation at 50 w, was  $8 \times 10^5$ . The durations of steady operation before shutdown were 10, 50, and 230 min. The mean lifetimes and absolute yields of delayed and photoneutron groups were found by analyzing each decay curve into a sum of decreasing exponentials and using the theory of pile kinetics. The yields were corrected to infinite irradiation time. These results are compared with data obtained by others. The comparison shows that the energetic  $\gamma$ -rays of fission products which produce photoneutrons in the heavy water are absorbed to the extent of about 26% in the heavy water and 74% in the uranium rods. A table of recommended mean lifetimes and absolute yields of delayed and photoneutrons is given for use in the kinetics of heavy water piles such as ZEEP. Some quantitative data on the effects of the control plates and shutoff rods are included. (auth)

3034

REACTOR POWER CALIBRATION. M. A. Schultz and J. C. Connor (Westinghouse Electric Corp., Pittsburgh, Penna.) *Nucleonics* 12, No. 2, 8-12 (1954) Feb.

Two methods for continuously measuring the average neutron flux of reactors are discussed. In one method, a large number of detectors are placed uniformly throughout the core and an average taken of their readings. The other method involves placing a detector sufficiently far from the core that the core can be considered a point source of neutrons, and local neutron density variations within the core will be insignificant. The two methods are discussed from the standpoint of application in power calibration of nuclear power plants. It is concluded that thermal measurements offer the best approach to power reactor control, and that neutron-measuring instruments are not suitable for power calibrations of nuclear power plants even when fairly complicated correction schemes are used with them, but are of value for safety and alarm purposes. (C.H.)

# NUCLEAR TRANSFORMATION

3035

Pennsylvania Univ.

PHOTO PROTONS FROM In, Ce, AND Bi. M. E. Toms, E.

E. Carroll, Jr., G. K. Rosenblum, and W. E. Stephens. [1953]. 23p. (AD-13709)

The charged particles ejected from In, Ce, and Bi foils by 24-Mev betatron x rays were observed in nuclear emulsion. The yields of photoprotons, photodeuterons, and photoalpha particles were determined, and the energy and angular distributions of the photoprotons were measured and compared with theoretical calculations based on the evaporation process and on the direct photo effect. The energy distributions observed indicate a large fraction of direct photo effect. The marked forward asymmetry was observed in the angular distributions from In and Bi. (auth)

3036

REACTION ENERGY OF  $O^{18}(p, \alpha)N^{15}$  AND THE ATOMIC MASS OF OXYGEN 18. Curt Mileikowsky (Nobel Inst. of Physics, Stockholm). *Arkiv Fysik* 7, 89-108 (1954).

Equipment and techniques are described with which the reaction energy of the  $O^{18}(p, \alpha)N^{15}$  reaction, and subsequent the mass of  $O^{18}$ , were determined. The values obtained are  $3.961 \pm 0.009$  Mev and 18.004848 amu, respectively. (L.M.T.)

3037

REACTION ENERGY OF  $Ne^{20}(d, \alpha)F^{18}$  BY MAGNETIC ANALYSIS. Curt Mileikowsky (Nobel Inst. of Physics, Stockholm). *Arkiv Fysik* 7, 117-19 (1954).

A Q value of  $2.791 \pm 0.009$  Mev is reported for this reaction. (L.M.T.)

3038

SPECIAL MECHANISMS IN THE REACTION  $Li^7(p, \gamma)^8Be$ . D. H. Wilkinson (Cavendish Lab., Cambridge, England). *Phil. Mag.* (7) 45, 259-76 (1954) Mar.

The course of the reaction  $Li^7(p, \gamma)^8Be$  is an unusual one: above the strong resonance at  $E_p = 440$  kev the cross section shows a background that, apart from weak resonances, increases steadily with increasing proton energy until at least  $E_p = 5.2$  Mev. It is suggested that this background has two origins: at the lower values of  $E_p$  it is due to direct radiative transitions between a free proton state and a bound state of  $Be^8$ —no compound nucleus is formed; at the higher values of  $E_p$  it is due to a process inverse to the familiar 'giant resonances' of photodisintegration. The first contribution is calculated for a variety of conditions in LS and in jj coupling; the second is deduced from the known properties of neighboring photodisintegration cross sections. The two processes together give a good account of the experimental results; there is some suggestion that the 'radius' of  $Be^8$  may be about  $3.2 \times 10^{-13}$  cm. (auth)

3039

SYSTEMATICS OF PHOTONEUTRON REACTIONS. R. Nathans and J. Halpern (Univ. of Penna., Philadelphia). *Phys. Rev.* 93, 437-42 (1954) Feb. 1.

Properties of the giant dipole resonances for  $(\gamma, n)$  reactions have been measured for 14 singly isotopic elements distributed throughout the range of z values. Systematics are reported for the behavior of the integrated cross sections, the energies at which the dipole resonances attain a maximum cross section, the values of the cross sections at these energies, and the widths of the resonances. Anomalously narrow widths are reported for elements with neutron numbers in the vicinity of the magic numbers. (auth)

3040

ELECTRODISINTEGRATION OF  $Cu^{63}$ ,  $Zn^{64}$ ,  $Ag^{109}$ , and Ta. Karl L. Brown and Richard Wilson (Stanford Univ., Calif.). *Phys. Rev.* 93, 443-52 (1954) Feb. 1.

The ratio of the  $(\gamma, n)$  photodisintegration cross section to the  $(e, e' n)$  electrodisintegration cross section for the isotopes  $Cu^{63}$ ,  $Zn^{64}$ ,  $Ag^{109}$ , and  $Ta^{181}$  was measured



for electron energies of 24 to 35 Mev. This ratio was found to decrease with energy in contrast with the Weizsäcker-Williams approximation which predicts a constant ratio. However, the Weizsäcker-Williams method does yield a result which is of the right order of magnitude for Cu, Zn, and Ag and which is within a factor of two of the observed value of Ta. Assuming approximately one-half of the total photon absorption of nuclei to be attributed to the  $(\gamma, n)$  reaction, then comparison of the experimental results for Cu, Zn, and Ag with calculations of Blair is consistent with the suggestion of Bethe and Levinger that the main absorption mechanism of nuclei for photons is electric dipole with a contribution of ~6 percent electric quadrupole absorption. However, for Ta no simple correlation between experiment and theory was found. This is attributed to a failure of the Born approximation used in the Blair calculations. (auth)

3041

EXPERIMENTAL STUDIES OF (p,t) REACTIONS. B. L. Cohen and T. H. Handley (Oak Ridge National Lab., Tenn.). *Phys. Rev.* **93**, 514-17(1954) Feb. 1.

Several (p,t) reactions in heavy nuclei are studied by measuring excitation functions and angular distributions. While the data are not sufficiently extensive to justify general conclusions, they seem to indicate that: (1) a "pick-up" process is important only when the target nucleus contains two loosely bound neutrons; and (2) the inherent probability for the emission of tritons in the breakup of a compound nucleus is not much (if any) less than for the emission of neutrons or protons. (auth)

3042

INTERNAL COMPTON EFFECT IN  $\text{Ba}^{137}$ . Larry Spruch and G. Goertzel (New York Univ. *Phys. Rev.* **93**, 642(1954) Feb. 1.

The measured angular distribution of continuous  $\gamma$  rays resulting from internal conversion has been found to differ markedly from theoretical predictions. However, the theory ignores among other things, the effect of the Coulomb field on the electron in the intermediate and final state. For  $\text{Ba}^{137}$  this defect can not be eliminated by a quantum calculation using Born approximation. It was thought that quantum calculations of the ratio of continuous  $\gamma$  rays to internally converted electrons should be more reliable, but this did not prove true. Again, the source of error seemed most likely to be the neglect of the Coulomb field. (L.M.T.)

3043

ANGULAR DISTRIBUTION OF PROTONS FROM THE REACTION  $\text{B}^{10}(\text{d}, \text{p})\text{B}^{11}$ . William W. Pratt (State Univ. of Iowa, Iowa City). *Phys. Rev.* **93**, 816-17 (1954) Feb. 15.

The angular distributions of the four longest-range proton groups have been measured in the forward direction using a nuclear plate scattering chamber. The deuteron energy was 3.03 Mev. The observed angular distributions were not in agreement with stripping theory, indicating a relatively large contribution from compound nucleus formation. (auth)

3044

PULSE-HEIGHT MEASUREMENTS OF RECOILS FROM  $\text{B}^{10}(\text{n}, \alpha)\text{Li}^7$ . James A. De Juren and Hyman Rosenwasser (National Bureau of Standards, Washington). *Phys. Rev.* **93**, 831-5 (1954) Feb. 15.

Thin films of B deposited over a small area by vacuum evaporation have been exposed to the National Bureau of Standards thermal neutron flux in pulse ionization chambers. Pulse ionization measurements in the past have yielded  $\text{He}^4$ -to- $\text{Li}^7$  pulse ratios considerably higher than the energy ratio of 1.753 from momentum conservation. Under suitable operating conditions ratios as low as 1.778 were

obtained. Columnar recombination appears to cause most of this variation. The probability of the reaction  $\text{B}^{10}(\text{n}, \alpha)\text{Li}^7$  going to the ground state was determined to be  $6.52 \pm 0.05\%$ . (auth)

3045

ELECTRIC EXCITATION OF LOW-LYING LEVELS IN SEPARATED WOLFRAM ISOTOPES. C. L. McClelland, Hans Mark, and Clark Goodman (Massachusetts Inst. of Tech., Cambridge). *Phys. Rev.* **93**, 904-5 (1954) Feb. 15.

Enriched tungsten in the form  $\text{WO}_3$  was bombarded by 2.5-Mev protons and the  $\gamma$  spectra resulting from electric excitation of the isotopes 182, 183, 184, and 186 was measured following the techniques of Huus and Bjerregaard (*Phys. Rev.* **92**, 1579 (1953)). The data obtained support the theoretical predictions of previous authors. (L.M.T.)

3046

GAMMA RAYS FROM THE PROTON BOMBARDMENT OF SODIUM. J. W. Teener, L. W. Seagondollar, and R. W. Krone (Univ. of Kansas, Lawrence). *Phys. Rev.* **93**, 1035-8 (1954) Mar. 1.

The yield of the (p, $\gamma$ ) capture process in  $\text{Na}^{23}$  has been studied for proton energies ranging between 0.85 and 1.70 Mev. Resonances were observed corresponding to excited levels of  $\text{Mg}^{24}$  at 12.71, 12.72, 12.79, 12.86, 12.90, 12.94, 12.97, 13.01, 13.02, 13.08, 13.10, 13.14, and 13.32 Mev. The energies of the  $\gamma$  rays emitted from the most pronounced resonances were measured by photographing the pulse-height spectrum obtained with a single crystal scintillation spectrometer. These experiments indicate two competing modes of decay: the radiative cascade decay leading to the ground state of  $\text{Mg}^{24}$  and the emission of a low-energy  $\gamma$  ray of energy 1.6 Mev which is attributed to the  $\text{Na}^{23}(\text{p}, \alpha\gamma)\text{Ne}^{20}$  reaction. No single-step transitions to the ground state were found in the capture process. Both two- and three-step transitions are observed, but all except one of the  $\gamma$ -ray cascades lead to the well-known 1.37-Mev state in  $\text{Mg}^{24}$ . (auth)

3047

GAMMA RADIATION FROM CERTAIN NUCLEAR REACTIONS. Rolf M. Sinclair (Rice Inst., Houston, Texas). *Phys. Rev.* **93**, 1082-6(1954) Mar. 1.

The gamma radiation from five nuclear reactions has been studied with a single NaI crystal. Three new resonances in the emission of 12-Mev radiation from the reaction  $\text{F}^{19}(\text{p}, \gamma)\text{Ne}^{20}$  have been found at 1092-kev, 1324-kev, and 1431-kev bombarding energy. The widths are, respectively, <1.2 kev, 4.0 kev, and 15.7 kev, and the cross sections at resonance are >0.05 mb, 0.081 mb, and 0.19 mb, respectively. The first resonance corresponds to one in the reaction  $\text{F}^{19}(\text{p}, \alpha\gamma)\text{O}^{16}$ , whereas the last two do not. All the transitions are to the 1.63-Mev level in  $\text{Ne}^{20}$  or to a nearby level. Possible values of the spin and parity of the excited levels in  $\text{Ne}^{20}$  are discussed. A search was made for gamma radiation from the bombardment of lithium by 650-kev deuterons. Upper limits for the production of 5-, 6-, and 7-Mev gamma rays are <2 mb, <1 mb, and <0.5 mb, respectively. A search was made for the radiative capture of deuterons in the bombardment of deuterium, helium, and oxygen. No capture gamma rays were observed, and upper limits for the cross section for these reactions are:  $\text{D}_2$ , <0.05  $\mu\text{b}$  at a deuteron energy of 1260 kev; He, <0.1 mb at 1055 kev; and  $\text{O}_2$ , <0.5 mb at 1100 kev. (auth)

3048

$\gamma$ -RADIATION FROM THE REACTION  $^{27}\text{Al}(\text{p}, \gamma)^{28}\text{Si}$ . J. G. Rutherglen, P. J. Grant, F. C. Flack, and W. M. Deuchars (Univ. of Glasgow, Scotland). *Proc. Phys. Soc. (London)* **A67**, 101-10(1954) Feb. 1.

The spectra of  $\gamma$ -radiation at the resonances for proton

capture in  $\text{Al}^{27}$  occurring at  $E_p = 404, 503, 630, 652$ , and  $677$  kev have been studied with a sodium iodide scintillation spectrometer. The angular distributions of the more prominent  $\gamma$ -ray components have been determined at each resonance. Spin and parity assignments to levels in  $\text{Si}^{28}$  are made on the basis of these and other measurements. (auth)

3049

## AN INTERPRETATION OF ASYMMETRIC FISSION.

Tatuya Sasakawa and Tatsu Sawada (Kyoto Univ., Japan). *Progr. Theoret. Phys. (Japan)* **10**, 585-7(1953) Nov.

A dynamic interpretation of asymmetric fission by low-energy neutrons is made by a hydrodynamic analysis of an inhomogeneous liquid drop model. (K.S.)

3050

THE  $\text{Li}^7(n,t)$  REACTION. R. L. Macklin and H. E. Banta (Oak Ridge National Lab., Tenn.). *Science* **119**, 350-1 (1954) Mar. 12.

Triton yield and cross sections for the  $\text{Li}^7(n,t)$  reaction were measured for graphite pile neutrons and Po-Be high-energy neutrons. The apparatus, calibrated for 1 c/s for  $6.70 \times 10^8$  tritons, gave 377 c/s for the pile sample and 1.5 c/s for the Po-Be sample. The pile had a neutron flux of  $2.0 \times 10^{10}$  n/cm<sup>2</sup> sec which gave a cross section of  $72 \pm 18$  mb. The Po-Be flux was  $2.7 \times 10^8$  n/cm<sup>2</sup> sec, and the  $\text{Li}^7(n,t)$  cross section was  $30 \pm 20$  mb. (J.S.R.)

3051

## SYMMETRY CORRELATIONS IN NUCLEAR REACTIONS.

A. Gamba (Univ. of Copenhagen, Denmark). *Nuovo cimento* (9) **11**, 323-5(1954) Mar. (In English)

It is shown that a correlation exists between the spin and isotopic spin polarization of particles emitted in a nuclear reaction and that this polarization is, in general, different for different states of symmetry. Examples are given. (J.S.R.)

## PARTICLE ACCELERATORS

3052

Atomic Energy Research Establishment, Harwell, Berks (England)

## GRID-FOCUSED LINEAR ACCELERATOR DYNAMICS.

J. S. Bell. Dec. 1953. 39p. (AERE-T/M-95)

A general account is given of the dynamics of a linear proton accelerator of the Berkeley type. Particular attention is paid to the effect of phase oscillation on the radial motion. Under certain circumstances, notably when the frequency of radial oscillation is just half that for phase oscillation, resonance occurs. Numerical integrations for a specific design, in which this resonance is swept over in the course of the acceleration, show considerable build-up of the radial motion. A perturbation theory gives approximate formulas which should enable the importance of the resonance to be estimated for other cases. Some approximate methods are developed for estimating the importance of resonance without doing numerical integrations for each case. The method of variation of parameters is used rather than the more usual treatment for Mathieu and Hill equations; this seems well adapted to the present problem and to give a novel insight into this type of resonance. An analysis is given of the importance of the grid wire spacing. If the spacing can be large, then the transparency of the grid can be better. The analysis is in agreement with the experience at Berkeley that quite widely spaced wires can be used without undue defocusing of the particles. (auth)

3053

## A COMPUTER FOR SOLVING SOME PROBLEMS IN CONNEXION WITH TRAVELLING-WAVE PARTICLE ACCELERATORS.

M. C. Crowley-Milling (Metropolitan-Vickers Electrical Co. Ltd., Manchester, England) *J. Sci. Instr.* **31**, 100-4(1954) Mar.

This paper describes the construction and operation of an analogue computer, designed to perform calculations of energy gain and to plot relative phase curves of particles in linear particle accelerators. It was constructed to solve problems concerned with bunching sections for electron accelerators, but only slight modification is necessary to make it suitable for calculations concerned with charged particles other than electrons. (auth)

3054

## ALTERNATING GRADIENT ELECTROSTATIC FOCUSING FOR LINEAR ACCELERATORS.

Lee C. Teng (Univ. of Minnesota, Minneapolis). *Rev. Sci. Instr.* **25**, 264-8(1954) Mar.

The properties of the focusing systems using alternating convergent and divergent electrostatic lenses which were proposed by Courant et al., and Blewett are studied in detail applied to Alvarez type of linear accelerators. It is found that the introduction and the removal of the focusing force of the system can be made approximately adiabatic by using half-length injection and extraction lenses. The appropriate choice of the parameters of the lenses in practical cases and the behavior of the ion beam going through such a system are discussed. The results can easily be reinterpreted to apply to magnetic lens systems. (auth)

3055

## ACHROMATIC BEAM TRANSLATION SYSTEMS FOR USE WITH THE LINEAR ACCELERATOR.

Wolfgang K. H. Panofsky and J. A. McIntyre (Stanford Univ., California). *Rev. Sci. Instr.* **25**, 287-90(1954) Mar.

The beam of a linear accelerator has desirable properties regarding its geometry but frequently contains secondaries produced in the machine and has an unsuitable energy spectrum. Two systems have been designed which translate the accelerator beam without energy dispersion. In the one system, now in operation, the emergent beam has an "energy focus," i.e., a point at which the initial beam geometry is reproduced independent of energy. The second system is designed to produce a beam translated but otherwise unmodified in geometry, independent of beam energy to the first order. Both systems permit easy control of energy width and produce a beam free from secondaries. (auth)

## RADIATION ABSORPTION AND SCATTERING

3056

Brookhaven National Lab.

## STUDIES ON THE PROPAGATION OF GAMMA RAYS IN AIR. FINAL PROGRESS REPORT [FOR] JUNE 30-

OCTOBER 15, 1953. W. Bernstein, D. Clareus, and M. M. Weiss. 12p. (BNL-1707; AFSWP-449)

The radiation dosage and energy distribution produced at several depths in a hole in the ground by a  $\text{Co}^{60}$  source suspended 100 feet above the ground has been studied as a function of the horizontal distance between the source and axis of the hole. The total dosage measurements were made with an ionization chamber; a scintillation spectrometer was used to determine the energy distribution. Some experiments were performed to evaluate the effects of shielding by lead and also by sand upon the total dosage. (For preceding period see BNL-1540.) (auth)

3057

Commissariat à l'Énergie Atomique (France)

CONTRIBUTION A L'ETUDE DE LA DIFFUSION  $\alpha$ -PROTON POUR DES PARTICULES  $\alpha$  D'ÉNERGIE COMPRENANT 3,1 ET 5,3 MeV. [Contribution to the Study of  $\alpha$ -p Scattering for  $\alpha$ -Particles of the Energies Between 3.1 and 5.3 MeV]. C. Ruhla. Nov. 1953. 29p. (CEA-230)

The study of  $\alpha$ -p scattering made under stringent experimental conditions has not revealed a group structure in the



proton distribution. The comparison of irregularities in the statistics from this study with those found by Tsien shows that there is no superposition. Consequently the conclusion was made that there is no resonance in the  $\alpha$ -p scattering for energies  $E'_\alpha$  between 3.1 and 5.3 Mev. The absence of resonance confirms the existence of a ground level of  $\text{Li}^6$  in the neighborhood of 1.8 Mev above that of  $\text{He}^4 + \text{H}$ . The comparison of the values of the experimental cross section to that of the coulomb diffusion cross section shows that the experimental cross section is the higher. The superposition of the curves of experimental diffusion and of coulomb diffusion is not complete. This discrepancy could be caused by a light nucleus effect. (tr-auth)

3058

Ames Lab.

TIME DEPENDENT VARIATIONAL PRINCIPLE. Saul Althshuler and J. F. Carlson. Mar. 22, 1954. 7p. Contract W-7405-eng-82. (ISC-471)

A variational principle for the transition amplitude is derived for interactions which are explicitly time dependent. The form is similar to the Schwinger variational principle for the transition amplitude in stationary-state collision theory. (auth)

3059

Naval Research Lab.

GAMMA RADIATION FROM INTERACTION OF 3.20-MEV NEUTRONS WITH VARIOUS MATERIALS. V. E. Scherrer, B. A. Allison, P. Shapiro, and W. R. Faust. Mar. 29, 1954. 9p. (NRL-4345)

Various lines in the  $\gamma$ -ray spectrum of thirteen elements, produced by interaction of 3.20-Mev neutrons, have been identified and calculations have been made of the corresponding cross section for  $\gamma$ -ray production. Use of large NaI spectrometer crystals effectively improved the resolution and increased the ease of interpretation of the various spectra. (auth)

3060

Carnegie Inst. of Tech.

PROGRESS REPORT [FOR] JULY-DECEMBER, 1953. R. Smoluchowski, C. Coleman, Y. Y. Li, W. H. Robinson, E. W. Toor, and L. Vassamillet. Mar. 1, 1954. 6p. Contract AT-30-GEN-359. (NYO-3488)

Work on grain-boundary diffusion of the Al-Cu system is progressing though some difficulties have been encountered. A furnace for growing single crystals and oriented bi-crystals has been completely rebuilt. Measurements on diamond made with the high-resolution small-angle scattering camera seem to indicate the existence of a maximum of scattering at about 0.018 rad. A fine-focus Guinier x-ray tube is being put into operation for the study of fine structure of Laue spots in imperfect crystals. A general theory of small-angle scattering has been developed. The diffraction by screw dislocations is being studied theoretically. The existence of coherent x-ray radiation produced by fast electrons passing through crystals is being investigated. (For preceding period see NYO-3486). (auth)

3061

Rochester Univ.

ANGULAR DISTRIBUTION OF CHARGE EXCHANGE SCATTERING OF 40 MEV.  $\pi^-$ -MESONS BY HYDROGEN. J. Tinlot and A. Roberts. Feb. 25, 1954. 31p. Contract AT(30-1)-875. (NYO-3835)

The angular distribution of the reaction  $\pi^- + \text{P} \rightarrow \pi^0 + \text{N}$  has been measured at a mean  $\pi^-$  energy of 40 Mev by detecting coincident photons corresponding to  $\pi^0$  emission at approximately  $0^\circ$ ,  $90^\circ$ , and  $180^\circ$ . The result is,  $d\sigma^0/d\Omega = (0.45 \pm 0.07) - (0.98 \pm 0.13) \cos\theta + (0.54 \pm 0.21) \cos^2\theta$  mb/ster. The corresponding total cross

section is  $\sigma_t^0 = 7.9 \pm 1.8$  mb. An analysis of this result and of previous measurements on  $\pi^+$  and  $\pi^-$  scattering at 37 Mev has been made, following the hypothesis of charge independence. It is possible to find two distinct types of solution. One type has positive  $T = \frac{1}{2}$  s-wave and  $T = \frac{3}{2}$  p-wave phase shifts, and negative  $T = \frac{3}{2}$  s-wave and  $T = \frac{1}{2}$  p-wave phase shifts. For the other type, the signs of the phase shifts are almost all reversed. Each type consists of a pair of solutions which are intrinsically indistinguishable at low energies because of the impossibility of determining the sign of the spin-flip scattering amplitude. A choice between the two types of solution is in principle possible with improved data. Predictions of the angular distributions of  $\pi^-$  elastic scattering are made. (auth)

3062

Radiation Lab., Univ. of Calif., Berkeley

THE SCATTERING OF ELECTRONS BY ATOMIC NUCLEI (thesis). Peter C. Giles. Sept. 1953. 40p. Contract W-7405-eng-48. (UCRL-2380)

The scattering of electrons and positrons at both large and small angles has been studied by observing their tracks as they penetrate nuclear emulsions. The measurements of the large-angle scattering ( $>4^\circ$ ) of both  $\sim 40$ -Mev electrons and positrons have been compared with the Rutherford scattering law. Within the statistics available, fair agreement was found with the relativistic Rutherford formula. A scheme of analysis for  $\gamma$  spectra based upon multiple scattering measurements of the pair-production electrons has been developed. It is applied to the determination of the energy spectrum of  $\gamma$  rays emitted by a beryllium target under bombardment by 330-Mev protons. (auth)

3063

Radiation Lab., Univ. of Calif., Berkeley

NUCLEAR EVENTS AT MODERATELY HIGH ENERGIES. Joseph V. Lepore and Richard N. Stuart. Nov. 17, 1953. 23p. Contract W-7405-eng-48. (UCRL-2386)

The statistical model, introduced by Fermi, is used to calculate the probabilities for various nuclear events at moderately high energies. Tables are presented giving the probabilities for various nuclear processes. (auth)

3064

SOME REMARKS ON THE RÔLE OF OVERLAPPING IN THE X-RAY SCATTERING BY CRYSTALS. I. Waller and S. O. Lundqvist (Univ. of Uppsala, Sweden). *Arkiv Fysik* 7, 121-4(1954).

The effect of overlapping between neighboring atoms of ions on x-ray scattering is considered for a crystal consisting of atoms or ions having complete electron shells. Specific application is then made to the case of a LiH crystal under the assumption of complete ionization, i.e., each ion is supposed to have two electrons in an ls-state with opposite spins. (L.M.T.)

3065

PROTON-PROTON SCATTERING AT HIGH ENERGIES.

Prabuddha Banerjee (Indian Assoc. for the Cultivation of Science, Calcutta, India). *Indian J. Phys.* 27, 557-61(1953) Nov.

The differential cross sections for proton-proton scattering are calculated in Born's approximation using potentials consisting of the tensor operator multiplied respectively by  $e^{-\lambda r}/\lambda r^2$  and  $e^{-\lambda r}/\lambda^2 r^3$ . Results for the second potential have been shown to give marked angular isotropy which agrees with the experimental results of proton-proton scattering at 345 Mev energy better than the existing calculations made with potentials derivable from field theories. (auth)

3066

THE SCATTERING OF SLOW ELECTRONS BY THE DIA-

TOMIC MOLECULES. II. ELASTIC SCATTERING BY THE HYDROGEN MOLECULES. Sigeru Nagahara (Toyama Univ., Japan. *J. Phys. Soc. Japan* 9, 52-5(1954) Jan.-Feb.

The elastic scattering of slow electrons by the  $H_2$  molecule is treated. The calculation was made for the following energies of the incident electron: 27.2, 17.1, 6.8 and 1.7 ev. The corresponding total cross sections were 9.163, 19.43, 43.84, and 33.23 atomic units. The remaining discrepancy with the observed values may be attributable to the effect of exchange and of inelastic collisions. (auth)

3067

SPINS AND PARITIES OF ENERGY LEVELS IN  $Pb^{208}$ .

L. G. Elliott, R. L. Graham, J. Walker, and J. L. Wolfson (Atomic Energy of Canada Ltd., Chalk River, Ontario). *Phys. Rev.* 93, 356(1954) Jan. 15.

K internal conversion coefficients of the 2.62-, 0.583-, 0.860-, and 0.511-Mev  $\gamma$ -ray transitions in  $Pb^{208}$ , following the decay of 3.1-min  $Tl^{208}$ , have been determined. Angular correlations between selected pairs of the  $\gamma$  rays are presented. Spin and parity assignments are made on the assumption of 0 spin and even parity for the ground state of  $Pb^{208}$ . (K.S.)

3068

ELASTIC SCATTERING OF INTERMEDIATE-ENERGY ALPHA PARTICLES BY GOLD. George W. Farwell and Harvey E. Wegner (Univ. of Washington, Seattle). *Phys. Rev.* 93, 356-7(1954) Jan. 15.

Elastic scattering of  $\alpha$  particles of 14 to 42 Mev in Au are reported, together with the variation of cross section with  $\alpha$  energies at scattering angles of 60 and 95° (lab system). At low energies, the cross section is given by Rutherford Coulomb scattering, whereas at high energies the cross section rapidly decreases with increasing  $\alpha$  energy. (K.S.)

3069

ENERGY LOSS OF CHARGED RELATIVISTIC PARTICLES AND THE ELEMENT PERIODS. Torbjörn Westermarck (Royal Inst. of Tech., Stockholm, Sweden). *Phys. Rev.* 93, 400 (1954) Feb. 1.

The stopping power per electron for charged relativistic particles is known to be a function of the electron density of the matter traversed. As the latter is a periodic property of the elements, the stopping power should also be periodic. A calculation shows the energy loss to have maxima at the alkali metals and minima between them. It is suggested that this effect partly caused the periodicity found long ago by Crowther in the absorption of  $Pa^{234}$  beta rays. Differences in stopping power for chemical isomers and element modifications are also discussed. (auth)

3070

ENERGY LOSS AND STRAGGLING OF ELECTRONS.

Charles Warner, III, and Fritz Rohrlich (Princeton Univ., N. J.). *Phys. Rev.* 93, 406-7(1954) Feb. 1.

The energy-straggling distribution and the most probable energy loss for 15.7-Mev electrons in Cu are calculated. Corrections for the resonance effect, bremsstrahlung, the polarization effect, and multiple scattering are included. The results are in very satisfactory agreement with recent experiments. The discrepancy in the most probable energy loss in Au is also discussed. (auth)

3071

HIGHER-ORDER POTENTIAL EFFECTS IN THE RADIATIVE CORRECTION TO SCATTERING OF SLOW ELECTRONS. M. H. Mittleman (Columbia Univ., New York). *Phys. Rev.* 93, 453-4 (1954) Feb. 1.

The radiative correction to the scattering of low-energy electrons by an external field has been calculated in first Born approximation in the external field. For strong fields or slow electrons this is not a valid ap-

proximation. With the assumption that only low-energy virtual photons contribute significantly to the effect, the radiative correction to the scattering of slow electrons is calculated to all orders of the external field. There is no change in the fractional radiative correction from the Born approximation result. (auth)

3072

CERENKOV RADIATION. Katsumi Tanaka (Argonne National Lab., Lemont, Ill.). *Phys. Rev.* 93, 459-60 (1954) Feb. 1. (cf. NSA 5-5449)

Cherenkov radiation is investigated for the following cases: charged particles and neutrons moving in isotropic crystals; charged particles moving in an arbitrary direction with respect to the optic axis in uniaxial crystals. (auth)

3073

ANNIHILATION OF POSITRONS IN CONDENSED MATERIALS. T. A. Pond (Princeton Univ., N. J.). *Phys. Rev.* 93, 478-9 (1954) Feb. 1.

Approximately  $\frac{1}{2}$  percent fewer positrons are found to annihilate with emission of two photons in amorphous solids and benzene than do so in metals. Fused quartz shows the same effect when compared with crystalline quartz. Assuming, with Bell and Graham, that this defect is due to triplet positronium in the amorphous materials, the mean life of triplet positronium against three-photon annihilation in the various materials is found to be approximately that observed in gases. Addition of a free radical to the benzene partially quenches the difference between pure benzene and metals. High-purity crystalline germanium is found to be similar to crystalline quartz. (auth)

3074

ELASTIC SCATTERING OF ELECTRONS BY THE COULOMB FIELD OF NUCLEI USING BORN APPROXIMATIONS. Vachaspati (Inst. for Theoretical Physics, Copenhagen, Denmark and Physical Research Lab., Ahmedabad, India). *Phys. Rev.* 93, 502-13 (1954) Feb. 1.

Calculations including the second Born cross section for the elastic scattering of electrons by nuclei are performed taking a model for which the matrix elements are particularly simple. The potential corresponding to this model is a mixture of an attractive Coulomb and a repulsive Yukawa potential of range  $1/B$  and relative strength  $C$ . The density is given by  $\rho = -(C-1)\delta^3(r) + \frac{CB^2}{4\pi} \frac{e^{-Br}}{r}$ . Since the scattering is fairly insensitive to the details of the nuclear model, the calculations made here can be used to find scattering cross sections on different models by suitably choosing  $B$  and  $C$ . This is done here for the uniform density model, and the results are compared with the phase-shift calculations of Acheson for 15- to 35-Mev electrons. A fairly close agreement with his results is obtained up to medium elements ( $Z \lesssim 50$ ). (auth)

3075

SCATTERING OF 151- AND 188-Mev POSITIVE PIONS BY PROTONS. George Homa, Gerson Goldhaber, and Leon M. Lederman (Columbia Univ., New York). *Phys. Rev.* 93, 554-61(1954) Feb. 1.

A beam of  $\sim 200$ -Mev  $\pi^+$  mesons was defined inside the vacuum chamber of the Nevis cyclotron. Nuclear emulsion were exposed to a flux of about  $10^4$  mesons/cm<sup>2</sup>. The plate were scanned for pion-hydrogen scatterings, and 103 such events were observed in two interaction energies,  $151 \pm 7$  Mev and  $188 \pm 8$  Mev. Total cross sections of  $152 \pm 31$  and  $159 \pm 34 \times 10^{-27}$  cm<sup>2</sup>, respectively, were obtained. The data suggest that the angular distribution changes from backwards peaked to almost symmetric over this energy interval. The observations are not in agreement with the hypothesis of a  $P_{3/2}$ -wave resonance in this energy region. The best fit to the combined results includes a D-wave contri-



bution of  $-5.4^\circ$ , although satisfactory agreement may be obtained with only S and P waves. (auth)

3076

THE SCATTERING OF 45-Mev POSITIVE PIONS BY HYDROGEN. Jay Orear (Univ. of Chicago) and J. J. Lord and A. B. Weaver (Univ. of Washington, Seattle). *Phys. Rev.* **93**, 575-7 (1954) Feb. 1.

Standard Ilford G.5 plates were exposed in an improvised 46-Mev external pion beam of the Chicago cyclotron. Scatterings of the pions by the hydrogen in the emulsion were observed by scanning for recoil protons and examining the proton beginnings for an incoming and scattered pion. Energy-momentum conservation permits separation of similar looking nonhydrogen events from the pion-proton scatterings. The average pion energy in the plates was determined to be  $45 \pm 2$  Mev from 15 events where the recoil proton stops in the emulsion. A total cross section of  $(12 \pm 3)$  millibarns has been obtained from 37 pion-proton scatterings. No scatterings were observed less than  $79^\circ$ . Only four are less than  $90^\circ$ . A phase-shift analysis of the data gives  $\alpha_2 = -(5.7 \pm 1.2)^\circ$ ,  $\alpha_{33} = (4.4 \pm 1.1)^\circ$ , and  $\alpha_{31} = (2.4 \pm 1.8)^\circ$ . Since these particular phase shifts happen to give very little Coulomb interference, these data do not determine the absolute signs of the phase shifts. Upon comparison of these results with scattering data at other energies,  $\alpha_2$  appears to vary as the first power of the pion momentum and  $\alpha_{33}$  with the third power at pion energies less than 80 Mev. (auth)

3077

RADIATIVE EFFECTS IN MESON-NUCLEON SCATTERING. Stanley Deser (Harvard Univ., Cambridge, Mass.). *Phys. Rev.* **93**, 612-15 (1954) Feb. 1.

An integral equation is derived which sums the contributions of a certain (infinite) set of radiative corrections to lowest-order meson-nucleon scattering. This equation for the S matrix is examined, and an approximate treatment given. The resulting scattering amplitude is exhibited in the Thomson and high-energy limits. (auth)

3078

TOTAL INTERACTION CROSS SECTION OF PIONS WITH PROTONS AND DEUTERONS AT 1.0 Bev. R. L. Cool, L. Madansky, and O. Piccioni (Brookhaven National Lab., Upton, N. Y.). *Phys. Rev.* **93**, 637-8 (1954) Feb. 1.

The total cross sections of negative pions with H and the D-H difference have been measured at an average pion kinetic energy of 1.0 bev. (L.T.W.)

3079

KINEMATIC CRITERION FOR MESON PRODUCTION IN FUNDAMENTAL PARTICLE COLLISIONS. R. M. Sternheimer (Brookhaven National Lab., Upton, N. Y.). *Phys. Rev.* **93**, 642-3 (1954) Feb. 1.

An expression is developed for determining  $\theta_m$ , the maximum angle of recoil of the nucleons for the production of a meson in pion-nucleon or nucleon-nucleon collisions. (L.M.T.)

3080

PHASE-SHIFT ANALYSIS OF HIGH-ENERGY NUCLEON-NUCLEON SCATTERING. R. M. Thaler and J. Bengtson (Yale Univ., New Haven, Conn.). *Phys. Rev.* **93**, 643-4 (1954) Feb. 1.

An analysis of 240-Mev proton-proton scattering data in terms of p-wave anomalies yields results which are consistent with "charge independence". (L.M.T.)

3081

EFFECT OF  ${}^3P_2$ - ${}^3F_2$  COUPLING ON NUCLEON-NUCLEON SCATTERING. R. M. Thaler, J. Bengtson, and G. Breit (Yale Univ., New Haven, Conn.). *Phys. Rev.* **93**, 644-5 (1954) Feb. 1.

The effects of  ${}^3P_2$ - ${}^3F_2$  coupling in the case of p-p scatter-

ing was treated in resonance-theory scattering matrix formalism. Phase shifts for all  $J \geq 2$  were admitted, and no restriction on  ${}^3P_0$ , 1 states were made. Fits satisfying charge independence were found to exist in a large range of parameters, as well as fits giving an inverted order of P levels together with charge independence. (L.M.T.)

3082

ENERGY LEVELS IN  $N^{14}$  FROM THE SCATTERING OF PROTONS BY  $C^{13}$ . Edmund A. Milne (Calif. Inst. of Tech., Pasadena). *Phys. Rev.* **93**, 762-7 (1954) Feb. 15.

The differential cross section for the elastic scattering of protons by  $C^{13}$  has been determined in the energy range from 0.45 to 1.60 Mev at angles of 50, 90, 120, 140, and  $160^\circ$  in the center-of-mass system. Marked anomalies were found in the scattering at 0.55, 1.16, 1.47, and 1.55 Mev, corresponding to excited states in  $N^{14}$  at 8.06, 8.62, 8.90, and 8.98 Mev. The spins and parities of these states have been determined from a preliminary analysis of the data which also indicated an effect due to the broad resonance at 1.25 Mev in  $C^{13}(p,\gamma)N^{14}$ , corresponding to an excited state in  $N^{14}$  at 8.70 Mev. The assignment for the 8.06-Mev level is  $J = 1^-$ , for the 8.62-Mev level  $J = 0^+$ , and for the broad 8.70-Mev level  $J = 0^-$ . The probable assignment for the 8.90-Mev level is  $J = 3^-$  and for the 8.98-Mev level  $J = 1^+$ . The elastic scattering of protons by  $C^{12}$  was also measured from 300 to 550 kev at angles of every ten degrees in the center-of-mass system from 30 to  $160^\circ$ . (auth)

3083

GAMMA RAYS EXCITED BY THE INELASTIC SCATTERING OF NEUTRONS IN LEAD, BISMUTH, IRON, NICKEL, AND CHROMIUM. M. A. Rothman and C. E. Mandeville (Franklin Inst., Swarthmore, Penna.). *Phys. Rev.* **93**, 796-9 (1954) Feb. 15.

Using neutrons of the d-D reaction at an energy of 3.9 Mev,  $\gamma$  rays have been excited by the inelastic scattering process in Pb, Bi, Fe, Ni, and Cr. The energies of the  $\gamma$  rays were measured by scintillation spectrometry. (auth)

3084

ELASTIC SCATTERING OF ALPHA PARTICLES BY NEON. E. Goldberg, W. Haeberli, A. I. Galonsky, and R. A. Douglas (Univ. of Wis., Madison). *Phys. Rev.* **93**, 799-805 (1954) Feb. 15.

Differential cross sections for the elastic scattering of  $\alpha$  particles by Ne have been measured at four angles for  $\alpha$  energies from 2 to 4 Mev. Absolute values of the cross section are good to  $\pm 4\%$ . The angles chosen correspond to center-of-mass angles such as to simplify assignments of angular momentum to the scattered resonance wave. Because no nuclear spins are involved, the angular momentum of the scattered wave also fixes the parity and angular momentum of the compound state. Thirteen resonances were observed. Eleven are attributed to virtual states of  $Mg^{24}$  and two are assigned to virtual states of  $Mg^{26}$ . The experimental data were analyzed in terms of the Wigner-Eisenbud formalism to determine the additional level parameters:  $E_r$ ,  $\chi_\lambda^2$ , and  $\Delta_\lambda$ . The laboratory energies of the  $(Ne^{20} + \alpha)$  resonances in Mev and the total angular momentum and parity assignments of the virtual states are: 2.488 ( $1^-$ ), 2.573 ( $0^+$ ), 2.652 ( $2^+$ ), 2.903 ( $0^+$ ), 3.062 ( $1^-$ ), 3.184 ( $2^+$ ), 3.548 ( $3^-$ ), 3.780 ( $1^-$ ), 3.801 ( $2^+$ ), 3.839 ( $4^+$ ), and 3.923 ( $2^+$ ). Similarly, the assignments for  $(Ne^{22} + \alpha)$  resonances are 3.245 ( $3^-$ ) and 3.418 ( $3^-$ ). The resonances above 3.0-Mev bombarding energy were investigated for competing reactions. No competing reaction with cross sections greater than about one % of the elastic value were observed. (auth)

3085

INTERACTION BETWEEN  $D^3$  AND  $He^3$  IN THE NEIGHBOR-

HOOD OF THE 18.6-Mev LEVEL OF  $\text{Li}^6$ . G. Freier and H. Holmgren (Univ. of Minnesota, Minneapolis). *Phys. Rev.* **93**, 825-6 (1954) Feb. 15.

The elastic-scattering differential cross sections and the cross section for the reaction  $\text{He}^3(d,\alpha)\text{H}^1$  have been measured in the neighborhood of energies corresponding to the 18.6-Mev level in the compound nucleus  $\text{Li}^{8*}$ . The reaction data are essentially in agreement with earlier data having a maximum in the total cross section of approximately 0.94 b. The interference between the elastic scattering and reaction process make the elastic-scattering cross sections at  $\theta_{\text{c.m.}} = 65.4^\circ$  about 40% less than Rutherford scattering. (auth)

3086

INELASTIC SCATTERING OF PROTONS BY  $\text{Li}^7$ . F. Mozer, W. A. Fowler, and C. C. Lauritsen (California Inst. of Tech., Pasadena). *Phys. Rev.* **93**, 829-30 (1954) Feb. 15.

The absolute differential cross section for the inelastic scattering of protons by  $\text{Li}^7$  has been measured at ten scattering angles for incident proton energies near the 1030-kev resonance. The differential cross section is nearly isotropic at the resonance, whereas at higher energies the scattering shows marked fore-and-aft asymmetry, being predominantly in the backwards direction. The total cross section for inelastic scattering is  $41.6 \pm 3.0$  mb at an incident proton energy,  $E_1 = 1050$  kev;  $35.4 \pm 2.8$  mb at  $E_1 = 1140$  kev; and  $32.0 \pm 2.7$  mb at  $E_1 = 1240$  kev. (auth)

3087

ELASTIC SCATTERING OF PROTONS BY HELIUM AT 5.78 Mev. W. E. Kreger, W. Jentschke, and P. G. Kruger (Univ. of Illinois, Urbana). *Phys. Rev.* **93**, 837-42 (1954) Feb. 15.

The differential cross section for the scattering of 5.78-Mev protons by He has been measured with an accuracy of  $\pm 2\%$ . Scattered protons and recoil  $\alpha$  particles were detected in Ilford C-2 nuclear track plates, allowing the calculation of cross sections for 26 angles from  $16.2^\circ$  to  $154^\circ$  in the center-of-mass system. The differential cross sections per unit solid angle are given as a function of the center-of-mass scattering angle. The results, analyzed in terms of phase shifts, confirm the large splitting of the inverted  $P_{3/2}$ - $P_{1/2}$  doublet in  $\text{Li}^5$  and indicate the presence of a small negative D-wave phase shift. (auth)

3088

INTERACTION OF BETA PARTICLES WITH MATTER. Ralph H. Müller (Los Alamos Scientific Lab., N. Mex.). *Phys. Rev.* **93**, 891-2 (1954) Feb. 15.

A systematic study was made of the back-scattering of 2.0-Mev betas from  $\text{Y}^{90}$  by samples of infinite thickness for 32 elements ( $Z = 4$  to 83) and 22 compounds. It is definitely established that the relative back-scattering is a discontinuous function of  $Z$ , but strictly linear in  $Z$  within each period of the periodic system. The linear equations, relating back-scattering to  $Z$  within each period, when solved simultaneously, indicate discontinuities at  $Z = 10$ , 18, 36, and 54, corresponding to the rare gases which terminate the periods. The back-scattering from compounds is accurately predicted from the scattering of their constituent atoms. (auth)

3089

INCOHERENT NEUTRON SCATTERING BY POLY-CRYSTALS. G. Placzek (Inst. for Advanced Study, Princeton, N. J.). *Phys. Rev.* **93**, 895-6 (1954) Feb. 15.

In evaluating the total incoherent cross section  $\sigma$  of a polycrystal, it is customary to decompose  $\sigma$  into partial cross sections  $\sigma_1$  for production or destruction of l

phonons. In a previous paper (*Phys. Rev.* **86**, 377(1952)) the author derived a simple asymptotic expression for the cross section without recourse to the above method, and explicitly evaluated it in the Debye approximation. This expression holds for heavy nuclei as soon as the neutron energy is slightly larger than the Debye temperature, and for lighter nuclei at somewhat higher energies. This note is concerned with the problem of finding a simple and accurate representation of the cross section valid for all energies. The procedure consists of expressing the neutron variables (wavelength and velocity) in terms of the neutron energy  $E$  and thereupon expanding the cross section in powers of the ratio  $M^{-1}$  of neutron to nuclear mass:

$$\sigma = s + \sum_{n=1} \sigma^{(n)} M^{-n},$$

where  $s$  is the bound incoherent nuclear cross section. (auth)

3090

NO SINGLE SCATTERING OF ELECTRONS AT OBLIQUE INCIDENCE. Morton Hamermesh and James Monahan (Argonne National Lab., Lemont, Ill.). *Phys. Rev.* **93**, 963-5 (1954) Mar. 1.

A detailed calculation shows that effects of plural scattering of electrons are adequately described by the method of Goertzel and Cox (*Phys. Rev.* **63**, 37(1943)). (auth)

3091

SCATTERING OF 1-MEV NEUTRONS BY INTERMEDIATE AND HEAVY ELEMENTS. M. Walt and H. H. Barschall (Univ. of Wisconsin, Madison). *Phys. Rev.* **93**, 1062-8 (1954) Mar. 1.

Differential cross sections for elastic scattering of 1-Mev neutrons from 28 intermediate and heavy elements were measured at intervals of  $15^\circ$  from  $30^\circ$  to  $150^\circ$ . The angular distributions of neutrons scattered by neighboring elements have similar shapes, while those of elements with appreciably different atomic weight show marked differences. For all elements forward maxima were found, and elements with atomic weight below 140 exhibited additional maxima for scattering through  $180^\circ$ . Maxima at about  $110^\circ$  were observed for elements with atomic weight near 200. From the elastic scattering cross sections, inelastic collision cross sections, and transport cross sections were obtained. (auth)

3092

SCATTERING OF HIGH-ENERGY ELECTRONS BY HEAVY NUCLEI. Elizabeth Urey Baranger (California Inst. of Tech., Pasadena). *Phys. Rev.* **93**, 1127-8(1954). Mar.

Born approximations cannot be considered valid for the elastic scattering of high-energy electrons by heavy nuclei. Therefore, an analysis was made using the WKB method and results are presented in this note for the case of  $Z = 80$ . (L.M.T.)

3093

THE SIGN OF THE PHASE SHIFT IN THE ELASTIC SCATTERING OF ELECTRONS. D. R. Yennie and D. G. Ravenhall (Stanford Univ., California) and E. Baranger (California Inst. of Tech., Pasadena). *Phys. Rev.* **93**, 1128-9(1954) Mar. 1.

In the phase-shift analysis of the scattering of electrons from a nuclear charge distribution, the total phase shift can be expressed as the sum of the two terms:  $\eta_l = \eta_l^c + \delta_l$ .  $\eta_l^c$  is the phase shift of the  $l$ th partial wave for a pure Coulomb field and  $\delta_l$  is the additional phase shift due to the modification of the Coulomb field inside the nucleus. This note points out an error in the literature (*Proc. Phys. Soc. London* **A65**, 481(1952)) in which it is



asserted that for large  $l$ ,  $\delta_1$  approaches zero through positive values. (auth)

- 3094  
INVESTIGATION OF TRIPLET NEUTRON-PROTON SCATTERING IN THE LOW ENERGY REGION USING THE ECKART AND BARGMANN POTENTIALS. J. S. Turner (Univ. of Sydney, Australia). *Proc. Phys. Soc. (London)* A67, 111-16(1954) Feb. 1.

It is pointed out that the extension of some results obtained for a special form of potential by Bargmann leads to an especially simple expression for the asymptotic phase of the scattered S waves. The expansion of  $k \cot \eta_0$  in terms of energy contains two terms only, the third coefficient P and all later coefficients being identically zero. The procedure for fitting experimental results is easier since the unmodified effective range theory is now exact for the Bargmann potentials. Graphs are drawn to illustrate the types of potential chosen by this method and to compare them with the conventional forms. Other Bargmann potentials for which P is not zero are discussed more briefly and fitted to the low-energy data, and some conclusions are drawn about the implications of the coefficient P. (auth)

#### RADIATION EFFECTS

- \*3095  
Knolls Atomic Power Lab.  
THE EFFECT OF SHORT TIME MODERATE FLUX NEUTRON IRRADIATIONS ON THE MECHANICAL PROPERTIES OF SOME METALS. F. W. Kunz and A. N. Holden. Feb. 19, 1954. 45p. Contract W-31-109-eng-52. (KAPL-1066)

Single crystals of iron, lead, and zinc were irradiated at room temperature to a total flux of  $10^{18}$  nvt to determine the effect of neutron irradiation on the mechanical properties of these metals. The flow stress of the iron and zinc crystals as measured from load versus elongation curves was markedly increased after the neutron exposure. The flow stress of the lead crystals remained unchanged after irradiation. Irradiated iron crystals were annealed at temperatures ranging from 200 to 500°C for times ranging from one to  $10^4$  minutes, following which they were tested in tension to determine the extent of recovery of the mechanical properties. The extent of recovery was determined by comparing the observed yield strength of the partially recovered crystals with yield strength of crystals in both the irradiated and unirradiated condition. An equation of the form  $\tau = A \exp(Q/kT)$  was found relating the time for any fixed amount of recovery to the absolute recovery temperature. The determined activation energy for recovery Q is equal to the activation energy for self-diffusion in iron. Various radiation-hardening mechanisms are also critically reviewed. (auth)

- \*3096  
North American Aviation, Inc.  
ELECTRON MICROSCOPE STUDY OF SLIP BANDS IN RADIATION DAMAGED ALUMINUM CRYSTALS. E. M. Kelly. Mar. 15, 1954. 15p. Contract AT-11-1-gen-8. (NAA-SR-261)

The effect of 39.6-Mev  $\alpha$  particles on the slip-band structure of aluminum crystals strained after exposure has been studied with an electron microscope. Although there is no apparent difference between irradiated and control samples strained at room temperature, irradiation appears to increase the amount of slip which can take place in the case of samples bombarded and measured at temperatures near the liquid nitrogen point. (auth)

- 3097  
CONDUCTIVITY INDUCED IN INSULATING MATERIALS BY X-RAYS. J. F. Fowler and F. T. Farmer (Royal

Victoria Infirmary, Newcastle upon Tyne, England). *Nature* 173, 317-18(1954) Feb. 13.

The conductivity induced in "Perspex" and polythene by x radiation were measured. The equilibrium induced current  $i$  in polythene is related to the dose rate  $R$  by the relationship  $i \propto R^{0.8 \pm 0.05}$  over the range  $R = 0.05$  to 20 r/min and 20 to 80°C. The dependence of induced current on dose rate in "Perspex" is given by  $i \propto R$  over the range 0.5 to 30 r/min and 20 to 90°C. It is believed that in polythene the distribution of electron traps below the conduction band is exponential, and in "Perspex" the distribution is uniform. (J.S.R.)

- 3098  
RADIATION EFFECTS IN INDIUM ANTIMONIDE. J. W. Cleland and J. H. Crawford, Jr. (Oak Ridge National Lab., Tenn.). *Phys. Rev.* 93, 894-5 (1954) Feb. 15.

Polycrystalline specimens of n- and p-type InSb were irradiated in the ORNL Graphite Reactor, and plots are presented of the Hall coefficients and resistivity as functions of temperature after various exposures. These preliminary studies indicate that (1) donor impurities are introduced into InSb by transmutations in the expected manner, and (2) lattice defects introduced by fast neutron bombardment act as electron traps in n-type material. (L.M.T.)

- 3099  
RADIATION DAMAGE IN  $\text{SiO}_2$  STRUCTURES. M. Wittels and F. A. Sherrill (Oak Ridge National Lab., Tennessee). *Phys. Rev.* 93, 1117-18(1954) Mar. 1.

Brief results are presented from a study of the effects of fast-neutron irradiation on four phases of the silicon-oxygen system, namely: (1) quartz, (2) low cristobalite, (3) low tridymite, and (4) glass. (L.M.T.)

- 3100  
THE WAVE LENGTH DEPENDENCE OF THE ELECTRIC CONDUCTIVITY OF CADMIUM SULFIDE SINGLE CRYSTALS ON RADIATION WITH X AND  $\gamma$  RAYS. G. Frohnmeyer, R. Glocker and D. Messner (Max Planck-Institut für Metallforschung, Stuttgart, Germany). *Z. Physik* 137, 117-25 (1954) Feb. (In German)

The wave-length dependence of the conductivity of CdS crystals on x and  $\gamma$  radiation in the range 2 to 0.001 kX was determined. There was confirmation of the theoretical assumption that only the fraction of the x-ray energy converted to Compton and photoelectron energies is effective. (tr-auth)

#### RADIOACTIVITY

- 3101  
California Inst. of Tech.  
FUNDAMENTAL RESEARCH IN SPECTROSCOPY OF SHORT WAVELENGTH X-RAYS AND GAMMA-RAYS. QUARTERLY REPORT [FOR] PERIOD OCTOBER 1 TO DECEMBER 31, 1953. 9p. Contracts N6onr-244, T.O. 4, Quarterly Report No. 27; AT(04-3)-8, Quarterly Report No. 5; and DA-04-495-Ord-444, Quarterly Report No. 3. (AECU-2823)

The measurement of 4  $\gamma$  rays emitted during the decay of  $\text{Cs}^{134}$  and a remeasurement of the 661-kev line of  $\text{Cs}^{137}$  were performed with a 2-m curved crystal  $\gamma$ -ray spectrometer. The  $\beta$ -ray spectrometer was used to study the decay of  $\text{La}^{140}$  and  $\text{Ba}^{140}$ . A new precision measurement of the 477-kev line of  $\text{Be}^7$  gave a result  $\gamma_{\text{Be}^7-\text{Li}^7} = 477.3 \pm 0.04$  kev. (For preceding period see AECU-2767.) (J.S.R.)

- 3102  
Ames Lab.  
THE DECAY SCHEME OF  $\text{Sb}^{125}$ . Sven A. E. Johansson. Dec. 7, 1953. 17p. Contract W-7405-eng-82. (ISC-432)  
The radiations from  $\text{Sb}^{125}$  have been studied by means of

a coincidence scintillation spectrometer. The energy values of three beta rays and eight gamma rays have been determined, and their coincidence relations have been completely investigated. A decay scheme is proposed. Assignments of spin and parity to the different levels have been made. (auth)

3103

Ames Lab.

THE DECAY OF  $UX_1$ ,  $UX_2$ , AND  $UZ$ . Sven A. E. Johansson. Feb. 17, 1954. 27p. Contract W-7405-eng-82. (ISC-462)

The decay of  $Th^{234}$  ( $UX_1$ ) and  $Pa^{234}$  ( $UX_2$  and  $UZ$ ) has been investigated by means of a coincidence scintillation spectrometer. Three  $\gamma$  rays at 29, 63, and 92 kev were found in  $UX_1$ . Four  $\gamma$  rays at 250, 750, 1000, and 1810 kev were found in  $UX_2$ , and four  $\gamma$  rays at 250, 760, 910, and 1680 kev were observed in  $UZ$ . The coincidence relations between the  $\gamma$  rays, and also between the  $\gamma$  rays and the  $\beta$  radiation, have been investigated. A decay scheme is proposed and spin and parity assignments have been made for the levels of  $Pa^{234}$  and  $U^{234}$ . (auth)

3104

Mound Lab.

A RECALCULATION OF THE ABSOLUTE VELOCITY OF THE  $Po^{214}$  ALPHA PARTICLE. (INFORMATION REPORT).

R. J. Clark. July 16, 1953. 13p. Contract AT-33-1-Gen-53. (MLM-876)

The experimental work reported in the literature regarding absolute-velocity determinations of alpha particles was critically reviewed. From these reviews, the data of G. H. Briggs (1936) for  $Po^{214}$  was chosen for recalculation with the latest available physical constants. Briggs' work was chosen because of the measuring technique employed and his detailed report of errors. A description of Briggs' method of measuring the magnetic momentum by magnetic balance technique is included. Other methods of measurements are also described. The results show that the absolute velocity of the alpha particle from  $Po^{214}$  is  $1.92160 \times 10^9$  cm/sec obtained by Briggs. The  $Po^{214}$  alpha energy is calculated from the velocity to be 7.6805 Mev, and the disintegration energy to be 7.8270 Mev. (auth)

3105

Carnegie Inst. of Tech.

RESEARCH AND DEVELOPMENT IN THE FIELD OF BETA-RAY SPECTROGRAPHY. INTERNAL CONVERSION IN  $Hg^{198}$ . TECHNICAL REPORT NO. 1 [FOR] MARCH 15, 1953 THROUGH JANUARY 31, 1954. G. W. Hinman and R. D. Leamer. 14p. Contract DA-36-061-ORD-340. (NP-5109)

The mixture of electric quadrupole and magnetic dipole radiations in the 675 kev gamma ray following  $\beta$ -decay of  $Au^{198}$  has been determined by measuring its K-shell internal conversion coefficient. The result was that  $K = 0.0156 \pm 0.0030$  indicating (86  $\pm$  9)% E2 and (14  $\pm$  9)% M1 for the mixture. It is estimated that the probability that the true value of  $\alpha_K$  lies within the limits quoted is 90%. (auth)

3106

STUDY OF  $\gamma$ -RADIATIONS OF  $^{99}Mo$  IN EQUILIBRIUM WITH  $^{99}Tc$ . [Etude des Rayonnements de  $\gamma$   $^{99}Mo$  en Equilibre avec  $^{99}Tc$ ]. Nadine Marty. Translated from *Compt. rend.* 230, 1270-2(1950). 4p. (AEC-tr-1844)

An abstract of this paper appears in *Nuclear Science Abstracts* as NSA 4-4702.

3107

THE BETA SPECTRUM OF INTERNAL CONVERSION EMITTED IN THE TRANSMUTATION IONIUM  $\rightarrow$  RADIUM. (Le Spectre Beta De Conversion Interne Emis Dans La Transmutation Ionium  $\rightarrow$  Radium). Salomon Rosenblum and Manuel Valadares. Translated from *Compt. rend.* 232, 501-3(1951). 4p. (AEC-tr-1847)

An abstract of this paper appears in *Nuclear Science Abstracts* as NSA 5-2622.

3108

GAMMA-RAYS, X-RAYS AND BREMSSTRAHLUNG FROM  $Tm^{170}$  SOURCES. K. Lidén and N. Starfelt (Univ. of Lund, Sweden). *Arkiv Fysik* 7, 109-19(1954).

The spectral distribution of the electromagnetic radiation from a thin  $Tm^{170}$  source placed between  $Tm$  radiators of various thickness has been investigated using a scintillation spectrometer. The experimental results have been used in a calculation of the relative intensities of the  $\gamma$  rays, x-rays, and bremsstrahlung from homogeneously activated  $Tm^{170}$  sources. The calculated distribution of the radiation from a  $Tm^{170}$  source, 1.0 g/cm<sup>2</sup>, shows good agreement with experiments. With a  $Tm^{170}$  source, 150 mg/cm<sup>2</sup>, the intensity of the continuous external bremsstrahlung excited by the  $\beta$ -particles in the source, amounts to 29% of the total intensity. With 1.0 g/cm<sup>2</sup> the spectral composition is 10% 84 kev  $\gamma$ -rays, 47%  $Tm + Yb$  K x-rays, and 43% bremsstrahlung. (auth)

3109

PROTON GROUPS FROM DEUTERON BOMBARDMENT OF  $Ne^{20}$  BY MAGNETIC ANALYSIS. TRANSITIONS TO THE GROUND STATE AND FIRST EXCITED STATE OF  $Ne^{21}$ . Katarina Ahnlund (Nobel Inst. of Physics, Stockholm). *Arkiv Fysik* 7, 155-63(1954).

3110

CHARACTERISTIC X-RAYS FROM THICK  $\beta$ -RAY SOURCES. K. Lidén and N. Starfelt (Univ. of Lund, Sweden). *Arkiv Fysik* 7, 193-6(1954).

Thick  $\beta$  sources of  $P^{32}$  and  $S^{35}$  were mounted between Pb or Sn radiator sheets, and the energy distribution of the external bremsstrahlung was determined by means of a scintillation spectrometer in conjunction with a photomultiplier and single-channel differential discriminator. Experiments showed the internal bremsstrahlung from the sources and the external bremsstrahlung from absorbers to be negligible. From the results it is concluded that every  $\beta$ -emitting isotope also emits its own characteristic x rays with an intensity depending on the  $\beta$  energy and the thickness of the source. (L.M.T.)

3111

DISINTEGRATION OF  $Au^{198}$ . L. G. Elliott, M. A. Preston, and J. L. Wolfson (Atomic Energy of Canada Ltd., Chalk River). *Can. J. Phys.* 32, 153-66 (1954) Feb.

In addition to the 411.77 kev  $\gamma$ -ray transition, two  $\gamma$ -ray transitions of energies 676.5  $\pm$  0.8 kev and 1088.9  $\pm$  0.9 kev have been observed in  $Hg^{198}$  following the disintegration of  $Au^{198}$ . The intensities of these transitions were found to be  $(8.20 \pm 0.56) \times 10^{-3}$  and  $(1.63 \pm 0.12) \times 10^{-3}$  per disintegration, respectively. The K conversion coefficient of the 676.5 kev transition was measured as  $0.0224 \pm 0.0019$ , identifying the radiation as a mixture of magnetic dipole and electric quadrupole. The K conversion coefficient of the 1088.9 kev transition was measured as  $0.0045 \pm 0.00034$ , identifying this radiation as electric quadrupole. A  $\beta$ -transition to the ground state of  $Hg^{198}$ , of energy 1371 kev and intensity  $(2.5 \pm 0.5) \times 10^{-4}$  per disintegration, has been observed and identified as a third order forbidden transition. The shape of this spectrum has been studied above the end point of the intense 959 kev  $\beta$ -transition. Of the four combinations considered for the  $\beta$ -decay interaction, viz. SA, VA, ST, VT, it was found that the experimental shape can be fitted by any one of VA, ST, or VT, but not by The log  $f_0 t$  value for the transition is 11.7. A disintegration scheme is proposed in which the excited states of  $Hg^{198}$  at 412 and 1089 kev are each assigned spin 2 and even parity, the ground state of  $Au^{198}$  spin 3 and odd parity. (auth)



3112

INTERNAL CONVERSION COEFFICIENT OF Ba<sup>137</sup>.

Toshio Azuma (Naniwa Univ., Sakai, Osaka, Japan). *J. Phys. Soc. Japan* 9, 1-3 (1954) Jan.-Feb.

The internal conversion coefficient of Ba<sup>137</sup> has been investigated with a double-coil, magnetic-lens, beta-ray spectrometer. The relative intensities of the internal conversion electrons of the 663-kev  $\gamma$  ray for K and L, L and M energy levels have been estimated as  $4.62 \pm 0.18$  and  $15.0 \pm 0.8$ , respectively. The value of K/L is in accord with the previous experimental values, and that of L/M is presented as a new value. (auth)

3113

ESTIMATING RADIUM AND URANIUM SURFACE CONTAMINATION. Eugene V. Barry, Leonard R. Solon, and Hanson Blatz (New York Operations Office, AEC). *Nucleonics* 12, No. 2, 59-61 (1954) Feb.

Known amounts of Ra and U were used to contaminant steel and glass plates, and their subsequent activity measured with three calibrated nuclear survey instruments. Indices obtained relate the measured activity to the specific contamination measured in mass of radioactive material per unit area. Application of the data obtained to estimates of Ra and U surface contamination is discussed. (C.H.)

3114

A NEW METHOD FOR MEASURING AUGER TRANSITIONS. Charles E. Roos (Johns Hopkins Univ., Baltimore). *Phys. Rev.* 93, 401-5 (1954) Feb. 1.

The K fluorescence yields ( $w_K$ ) of eight elements: zirconium, niobium, molybdenum, rhodium, palladium, silver, cadmium, and tin were measured by a new x-ray method involving the use of a NaI-Tl scintillation counter. This counter made it possible to detect the fluorescent x-rays radiated over an effective solid angle of  $2\pi$  steradians. The values of  $w_K$  are Zr-0.645; Nb-0.713; Mo-0.714; Rh-0.779; Pd-0.782; Ag-0.814; Cd-0.819; and Sn-0.840, all with an accuracy of  $\pm 3\%$ . These results confirm the theoretical predictions of Wentzel that  $w_K/(1-w_K)$  is a function of  $Z^4$ , and they are in close agreement with the theoretically predicted values of Burhop and Pincherle. (auth)

3115

ANGULAR CORRELATIONS OF GAMMA RAYS IN Ta<sup>181</sup>. F. K. McGowan (Oak Ridge National Lab., Tenn.). *Phys. Rev.* 93, 471-7 (1954) Feb. 1.

The directional angular correlation of three different gamma-ray cascades in Ta<sup>181</sup> have been measured with a fast delayed-coincidence scintillation spectrometer employing NaI phosphors as detectors. An interpretation of the results, in combination with measured K-shell internal-conversion coefficients, indicates that an unambiguous assignment of the angular momenta of three excited states in Ta<sup>181</sup> and a classification of the gamma rays are possible. The spin sequences are as follows: for the 132-480 kev gamma-ray cascade  $5/2(E2)9/2(E2+M1)7/2$  with  $\delta_{480}$ , the square root of the intensity ratio of electric quadrupole to magnetic dipole radiation, equal to -1.25; for 132-345 kev gamma-ray cascade  $5/2(E2)9/2(E2+M1)9/2$  with  $\delta_{345} = 1.0 \pm 0.2$ ; and for the 345-135 kev gamma-ray cascade  $9/2(E2+M1)9/2(E2+M1)7/2$  with  $\delta_{345} = 0.95 \pm 0.10$  and  $\delta_{135} = 0.5 \pm 0.05$ . The observed angular correlation functions for the 132-480 kev and 132-345 kev cascades indicate an appreciable attenuation by perturbing interactions in the intermediate state of the nucleus by its surroundings, even in the liquid state. For polycrystalline hafnium metal and hafnium compounds, the attenuation coefficients are smaller than the "hard core" values for a static electric quadrupole interaction. (auth)

3116

## MIXED GAMMA-MIXED GAMMA ANGULAR CORRELATION.

M. E. Rose (Oak Ridge National Lab., Tenn.) *Phys. Rev.* 93, 477 (1954) Feb. 1.

The  $\gamma$ - $\gamma$  correlation in which both radiations are mixed, with arbitrary admixture ratios, is briefly discussed. (auth)

3117

RADIOACTIVE Si<sup>31</sup>. W. S. Lyon and J. J. Manning (Oak Ridge National Lab., Tenn.). *Phys. Rev.* 93, 501 (1954) Feb. 1.

One  $\gamma$  ray of energy 1.26 Mev is found to accompany 0.07% of the disintegrations of Si<sup>31</sup>. The thermal neutron atomic activation cross section for the reaction Si<sup>30</sup>(n, $\gamma$ ) Si<sup>31</sup> is observed to be  $2.9 \pm 0.3$  mb. (auth)

3118

INTERNAL BREMSSTRAHLUNG AND IONIZATION ACCOMPANYING BETA DECAY. F. Boehm and C. S. Wu (Columbia Univ., New York). *Phys. Rev.* 93, 518-23 (1954) Feb. 1.

Internal bremsstrahlung spectra from S<sup>35</sup> and Pm<sup>147</sup> have been investigated with the NaI scintillation spectrometer. Both the absolute cross section of production and the energy distribution agree with theoretical predictions. The theoretical internal bremsstrahlung spectrum of RaE was calculated by using both the observed forbidden  $\beta$  spectrum and an allowed  $\beta$  distribution. No significant differences in shape were found in these two cases except in the absolute cross section of production. The ionization accompanying beta decay was studied in the case of RaE and also in Pm<sup>147</sup> by measuring the characteristic x-rays in an NaI scintillation counter as well as in a proportional counter spectrometer. Both K and L radiations were observed, and their absolute cross sections were compared with the theoretical calculations of Migdal, Feinberg, and Levinger. Because of the approximate nature of the theoretical calculations, the agreement between the theoretical and experimental results is considered satisfactory. (auth)

3119

ANGULAR CORRELATION OF THE CASCADE  $\gamma$  RAYS FROM THE DECAY OF <sup>84</sup>Po<sup>214</sup>. F. Demichelis and R. Malvano (Istituto di Fisica Sperimentale del Politecnico, Turin, Italy). *Phys. Rev.* 93, 526-7 (1954) Feb. 1.

This paper was published in *Nuovo cimento* (9) 10, 1359-66 (1953), in Italian, and was abstracted in *Nuclear Science Abstracts* as NSA 8-1247.

3120

BETA DECAY OF Np<sup>238</sup>. Hilding Siätis, John O. Rasmussen, Jr., and Hugo Atterling (Noble Inst. of Physics, Stockholm). *Phys. Rev.* 93, 646 (1954) Feb. 1.

The  $\beta$  and conversion electron spectra of Np<sup>238</sup> were investigated with a precision double-focusing spectrometer and a high-transmission intermediate-image spectrometer. The energies and intensities of observed conversion lines are presented, the lower-energy intensities being corrected for counter-window transmission loss. Of greatest interest is the evidence for additional  $\gamma$  transitions of 939 and 925 kev, although the latter was so weak as to be somewhat uncertain. (L.M.T.)

3121

ENERGY LEVELS IN Lu<sup>176</sup> AND Hf<sup>176</sup>. James R. Arnold (Univ. of Chicago). *Phys. Rev.* 93, 743-5 (1954) Feb. 15.

The energies of the three  $\gamma$  rays in cascade with the  $\beta^-$  emission of Lu<sup>176</sup> have been determined to be 306, 203, and 89 kev. Peak intensity and conversion x rays suggest the assignment of all transitions as E2. The energies support the theory of Bohr and Mottelson. The total K x-ray intensity shows no excess to be ascribed to a K-capture branch setting a limit of  $K/\beta^- < 0.1$ . The half life of Lu<sup>176</sup> is  $(2.15 \pm 0.10) \times 10^{10}$  yr. (auth)

3122

AN ISOMERIC STATE OF  $\text{Ga}^{65}$ . Bernd Crasemann (Univ. of California, Berkeley). *Phys. Rev.* **93**, 1034(1954) Mar. 1.

A positron activity of  $8.0 \pm 0.5$  minutes half life has been assigned to an isomeric state of  $\text{Ga}^{65}$  on the basis of chemical separation, cross bombardments, and excitation curves. Gamma rays of  $52 \pm 2$ ,  $92 \pm 4$ , and  $114 \pm 4$  kev were measured, which exhibited the 15-minute half life of the previously known activity of  $\text{Ga}^{65}$ . No 8-minute gamma ray was found. (auth)

3123

RADIATION FROM ANTIMONY 122. J. M. Cork, M. K. Brice, G. D. Hickman, and L. C. Schmid (Univ. of Michigan, Ann Arbor). *Phys. Rev.* **93**, 1059-61(1954) Mar. 1.

Neutron capture in enriched  $\text{Sb}^{121}$  yields radioactive  $\text{Sb}^{122}$  whose half life is found to be  $66.0 \pm 0.4$  hr. In addition to the two previously observed gamma rays, present studies with scintillation and conversion electron spectrometers indicate the existence of six previously unreported gammas. The energies are 95, 553, 556, 616, 647, 694, 1100, 1200 kev with possibly something at 1.9 Mev. K/L intensity ratios for the conversion lines are observed only for the 553- and 566-kev gammas. The high-energy lines are observed only with the scintillation spectrometer. The beta spectrum is resolved into components with maximum energies at  $2.00 \pm 0.03$ ,  $1.40 \pm 0.02$ , and 0.450 Mev, with possibly some other lower energy present. Three gamma energies in  $\text{Sb}^{124}$  are evaluated by their conversion electrons as 603.6, 644, and 727 kev. (auth)

3124

GAMMA RAYS FROM Ne. R. P. Foster, G. S. Stanford, and L. L. Lee, Jr. (Yale Univ., New Haven, Conn.). *Phys. Rev.* **93**, 1069-72(1954) Mar. 1.

The decay scheme of the low-lying excited states of  $\text{Ne}^{22}$  has been investigated by means of a proton gamma-ray coincidence study of the  $\text{F}^{19}(\alpha, p)\text{Ne}^{22}$  reaction using a  $\text{NaI}(\text{Tl})$  gamma-ray scintillation spectrometer. The excitation energies of the second and third excited states were rechecked and found to be 3.3 and 4.9 Mev, respectively. The results cast considerable doubt on the existence of the previously reported level at 0.6 Mev. For the 1.28-Mev excited state a single transition to the ground state was identified. The second excited state was found to decay principally by a cascade transition through the first excited state, although a weaker crossover transition direct to the ground state was also observed. The third excited state was found to decay through transitions to both the first excited and ground states. A discussion of possible spin and parity assignments by means of the Weisskopf relations is presented. (auth)

3125

RADIATIONS OF 13.9-Min  $\text{Ce}^{146}$  AND 24.4-Min  $\text{Pr}^{146}$ . W. Bernstein, S. S. Markowitz, and S. Katcoff (Brookhaven National Lab., Upton, N. Y.). *Phys. Rev.* **93**, 1073-5 (1954) Mar. 1.

The radiations of  $\text{Ce}^{146}$  and  $\text{Pr}^{146}$  fission products were investigated with a scintillation coincidence spectrometer. The 24.4-min  $\text{Pr}^{146}$  was shown to decay by two  $\beta$  branches of maximum energy  $2.3 \pm 0.2$  Mev and  $3.7 \pm 0.2$  Mev and of about equal intensity. Gamma rays of  $455 \pm 13$  kev,  $750 \pm 30$  kev, and  $1490 \pm 40$  kev were observed; the 455-kev  $\gamma$  ray was the most intense, and the 750-kev line was shown to consist of two  $\gamma$  rays of about the same energy. A probable decay scheme is given. The 13.9-min  $\text{Ce}^{146}$  was found to emit  $\beta$  rays of  $700 \pm 100$  kev maximum energy in coincidence with all of the  $\gamma$  rays. Abundant  $\gamma$  rays of  $110 \pm 5$  kev,  $142 \pm 5$  kev,  $220 \pm 10$  kev,  $320 \pm 10$  kev, and weak  $\gamma$  rays of about 50 kev, about 250 kev, and  $270 \pm 10$  kev were observed. The relative intensities and

the observed  $\gamma$ - $\gamma$  coincidences are tabulated, but the data were insufficient to determine a unique decay scheme. Some of the  $\gamma$  rays were partially internally converted giving rise to  $\text{Pr K x-rays}$ . (auth)

3126

ELECTRON CAPTURE IN THE DECAY OF  $\text{Na}^{22}$ . R. Sher and R. H. Miller (Princeton Univ., New Jersey). *Phys. Rev.* **93**, 1076-81(1954) Mar. 1.

The ratio of electron capture to positron emission in the decay of  $\text{Na}^{22}$  to the 1.28-Mev level in  $\text{Ne}^{22}$  has been determined by a comparison of the intensities of positron emission and 1.28-Mev radiation. The measurements were made with a coincidence arrangement employing a  $4\pi$  beta counter to detect the positrons and a scintillation counter for the  $\gamma$  rays. By varying the bias of a discriminator responding to the  $\gamma$  spectrum, one can determine the efficiency of the  $4\pi$  beta counter, and the product of this efficiency and the fraction of decays which undergo electron capture. These measurements lead to a value of  $0.110 \pm 0.006$  for the ratio of electron capture to positron emission. If one assumes that the  $\text{Na}^{22}$  decay is allowed ( $\Delta J = 1$ , no) the theoretical value is 0.1135. By a comparison of these values, an estimate of the magnitude of the Fierz interference term can be made. It is found, subject to the above assumption, that the ratio of the axial vector and tensor coupling constants  $C_A/C_T = (-1 \pm 2)$  percent. (auth)

3127

SHORT-LIVED METASTABLE STATES OF  $\text{W}^{182}$ . A. W. Sunyar (Brookhaven National Lab., Upton, N. Y.). *Phys. Rev.* **93**, 1122-3(1954) Mar.

Fast-coincidence techniques were used in measuring the half lives of two short-lived metastable states of  $\text{W}^{182}$ . Values of  $1.02 \pm 0.5 \times 10^{-9}$  and  $1.27 \times 10^{-9}$  sec are reported. (L.M.T.)

3128

DECAY OF  $\text{V}^{52}$ . J. M. LeBlanc, J. M. Cork, S. B. Burson, and W. C. Jordan (Argonne National Lab., Lemont, Ill.). *Phys. Rev.* **93**, 1124-5(1954) Mar. 1.

The decay of  $\text{V}^{52}$  was studied by means of  $180^\circ$  magnetic photographic spectrometers and a 10-channel coincidence scintillation spectrometer. Results indicate that  $\text{V}^{52}$  decays with a 3.75-min half life by the emission of a single  $\beta$  ray of energy 2.6 Mev followed by a 144-Mev  $\gamma$  ray. Neither the 2.6-min nor the 16-hr activity previously reported was found. (L.M.T.)

3129

BETA-RAY SPECTRUM OF  $\text{Mg}^{28}$ . J. L. Olsen and G. D. O'Kelley (California Research and Development Co., Livermore). *Phys. Rev.* **93**, 1125-6(1954) Mar. 1.

The  $\beta$  spectra of  $\text{Mg}^{28}$  was studied by means of a ring-focused, long magnetic-lens spectrometer in the energy range 100 to 3500 kev. The  $\beta$  energy maximum of 459 kev which was reproduced on 4 runs, is 9% greater than that found by Marquez (*Phys. Rev.* **90**, 330(1953)). (L.M.T.)

3130

EMISSION OF ELECTRON-POSITRON PAIRS FROM LIGHT NUCLEI. I. MONOPOLE TRANSITION IN  $^{16}\text{O}$ . S. Devons, G. Goldring, and G. R. Lindsey (Imperial College, London). *Proc. Phys. Soc. (London)* **A67**, 134-47 (1954) Feb. 1.

An apparatus is described for measuring the angular correlation of electron-positron pairs from light nuclei. The apparatus has been used to study the pairs emitted in the monopole transition from the first excited state of  $\text{O}^{16}$ . Measurements are also described of the excitation function for this state of  $\text{O}^{16}$  in the reaction  $\text{F}^{19}(\text{p}, \alpha)\text{O}^{16}$ , and of the absolute probability (half life) of the monopole transition. (auth)



3131

A CLOUD CHAMBER STUDY OF INTERNAL PAIRS FROM  $^{12}\text{C}^*$ . G. Harries (Clarendon Lab., Oxford, England). *Proc. Phys. Soc. (London)* **A67**, 153-7 (1954) Feb. 1.

The nature and multipolarity of the 4.45 Mev  $\gamma$  ray from carbon- $^{12}\text{C}^*$  are obtained from the angular distribution of the positrons and electrons of internal conversion pairs photographed in a cloud chamber. The transition is found to be of electric quadrupole origin. Accordingly, a spin of  $2^+$  is ascribed to the first excited level in  $\text{C}^{12}$  and a decay scheme is proposed for  $\text{C}^{12*}$  at the lower energies. A transformation formula is given which relates the spatial angular distribution of cloud-track pairs to the distribution of pair-angles projected on to a plane of reference. (auth)

#### RARE EARTHS AND RARE-EARTH COMPOUNDS

3132

TOTAL CROSS SECTIONS OF RARE EARTHS FOR FAST NEUTRONS. A. Okazaki, S. E. Darden, and R. B. Walton (Univ. of Wis., Madison). *Phys. Rev.* **93**, 461-3 (1954) Feb. 1.

The total neutron cross sections averaged over resonances have been measured for Nd, Sm, Er, Yb, and Hf as functions of neutron energy from 0.06 to 3 Mev. The cross-section curves have shapes which change gradually with atomic weight and are in agreement with the values predicted by the theory of Feshbach, Porter, and Weisskopf. (auth)

3133

NEW RADIOACTIVE NUCLIDES OF THE RARE EARTHS. Thomas H. Handley and Elmer L. Olson (Oak Ridge National Lab., Tenn.). *Phys. Rev.* **93**, 524-5 (1954) Feb. 1.

Proton bombardment of pure  $\text{Er}_2\text{O}_3$ , followed by ion-exchange separation, has yielded an unreported radio-nuclide of erbium with a 3.6-hour half life. It is assigned to  $\text{Er}^{161}$  and decays by K capture with gamma rays of 0.195, 0.824, and 1.12-Mev energy. Its daughter, 2.5-hour  $\text{Ho}^{161}$ , was also identified and was observed to decay by K capture with a 0.090-Mev gamma ray. (auth)

#### SPECTROSCOPY

3134

THEORY OF THE BETA SPECTROGRAPH, K. SIEGBAHN TYPE. [Theorie du spectrographie beta, type K. Siegbahn]. Genevieve Paquien and Pierre Grivet. Translated from *Compt. rend.* **230**, 196-8 (1950). 4p. (AEC-tr-1841)

An abstract of this paper appears in *Nuclear Science Abstracts* as NSA 4-2413.

3135

ZEEMAN EFFECT AND LINE BREADTH STUDIES OF THE MICROWAVE LINES OF OXYGEN. Robert M. Hill and Walter Gordy (Duke Univ., Durham, N. C.). *Phys. Rev.* **93**, 1019-22 (1954) Mar. 1.

Measurements made at 90°K and at 300°K on the  $\text{O}_2$  line breadths show that the line breadth parameter,  $\Delta\nu$ , varies as  $T^{-x}$ , with x ranging in value from 0.76 for the 9-line to 0.90 for the 1-line. The type of variation of x with the rotational quantum number N indicates that both rotational resonance and quadrupole moment interactions are important factors in determining the line breadths. The Zeeman splittings observed for the  $1_{-}$ , the  $1_+$ , and the  $3_{-}$  lines are in good agreement with the splitting predicted from first-order perturbation theory. (auth)

#### THEORETICAL PHYSICS

3136

Los Alamos Scientific Lab.

NUMERICAL SOLUTION OF THREE SIMULTANEOUS

SECOND-ORDER DIFFERENTIAL EQUATIONS ARISING IN THE LOW ENERGY MESON THEORY OF THE DEUTERON. Harwood G. Kolsky. [1954] 9p. Contract [W-7405-eng-36]. (AECU-2831)

The meson potential functions derived by Klein for the low-energy deuteron case were subjected to numerical computations. The calculations were performed by a floating decimal interpretive routine, constituting a dual coding system. The numerical results are compared with experimental values due to Snow. In achieving the results, it was found necessary to use different values of a (meson coupling constant) for the first power and squared terms. It is concluded that an extension of perturbation theory to higher degree terms will be very difficult. (K.S.)

3137

EXPERIMENTAL CONSEQUENCES OF THE ELECTRO-NEUTRINO THEORY. Bernard Jouvett. *Compt. rend.* **238**, 55-7 (1954) Jan. 4. (In French)

The possibility of the creation of electron pairs by neutrinos and the existence of a new stable particle with zero mass, spin 1, and zero charge are discussed. (tr-auth)

3138

PROPAGATION AND WAVEFUNCTIONS IN QUANTUM-THEORY OF FIELDS. E. Freese (Max Planck Institut für Physik, Göttingen, Germany). *Nuovo cimento* (9) **11**, 312-15 (1954) Mar. (In English)

Propagation functions are introduced for the solution of scattering problems in which the coupling constant is large, by means of Dyson's S matrix. (J.S.R.)

3139

A NON-PERTURBATION TREATMENT OF SCATTERING AND THE "WENTZEL-EXAMPLE". M. Cini (Univ. of Turin, Italy), G. Morpurgo and B. Touschek (Univ. of Rome, Italy). *Nuovo cimento* (9) **11**, 316-17 (1954) Mar. (In English)

The covariant method, recently proposed by Cini and Fubina (*Nuovo cimento* **11**, 142 (1954) Jan. 1), is applied successfully to the example discussed by Morpurgo and Touschek (NSA 8-1763). (J.S.R.)

3140

THE QUANTUM-MECHANICAL PARTITION FUNCTION. G. V. Chester (King's Coll., London, England). *Phys. Rev.* **93**, 606-11 (1954) Feb. 1.

A simple method is demonstrated of expanding the quantum-mechanical partition function in powers of the interaction potential between the particles of the system. The result is valid for all types of statistics and for all types of interaction, provided the interaction potential is nonsingular. The general term is expressed, in terms of known quantities, in a compact form. It is shown that the series must be considerably modified for the case in which the potential is singular. The convergence of the series is discussed briefly. (auth)

3141

THE THEORY OF QUANTIZED FIELDS. V. Julian Schwinger (Harvard Univ., Cambridge, Mass.). *Phys. Rev.* **93**, 615-28 (1954) Feb. 1.

The Dirac field, as perturbed by a time-dependent external electromagnetic field that reduces to zero on the boundary surfaces, is the object of discussion. Apart from the modification of the Green's function, the transformation function differs in form from that of the field-free case only by the occurrence of a field-dependent numerical factor, which is expressed as an infinite determinant. It is shown that, for the class of fields characterized by finite space-time integrated energy densities, a modification of this determinant is an integral function of the parameter measuring the strength of the field and can therefore be expressed as a power series with an infinite radius of convergence. The Green's function is derived therefrom as the ratio of two such

power series. The transformation function is used as a generating function for the elements of the occupation number labelled scattering matrix  $S$ , and, in particular, formulas are derived for the probabilities of creating  $n$  pairs, for a system initially in the vacuum state. The general matrix element of  $S$  is presented, in terms of the classification that employs a time-reversed description for the negative frequency modes, with the aid of a related matrix  $\Sigma$ , which can be viewed as describing the development of the system in proper time. The latter is characterized as indefinite unitary, in contrast with the unitary property of  $S$ , which is verified directly. Two appendices are devoted to determinantal properties. (auth)

3142

ELEMENTARY PARTICLES AND THE LAMB-RETHETFORD LINE SHIFT. Leslie L. Foldy (Case Inst. of Tech., Cleveland, Ohio). *Phys. Rev.* **93**, 880-1 (1954) Feb. 15.

According to the principles of contemporary quantum electrodynamics, the existence of a charged particle field of any kind results in a vacuum polarization contribution to the Lamb-Retherford line shift of an amount proportional to the square of the charge and inversely proportional to the square of the mass of the field particle. On the basis of the present agreement between theory and experiment with respect to the line shift in H, it may be concluded that no singly charged particles of spin  $\frac{1}{2}$  with mass less than four electron masses, other than the electron and positron, can exist without spoiling this agreement. Similar reasoning argues against the existence of singly charged particles of spin 0 with mass less than twice the electron mass. For doubly charged particles these limits are quadrupled. The assumptions involved in these conclusions as well as some experimental evidence are briefly discussed. (auth)

3143

ON THE CLASSICAL THEORY OF PARTICLES INTERACTING WITH ELECTROMAGNETIC AND MESONIC FIELDS. I. Peter Havas (Lehigh Univ. Bethlehem, Penna.) *Phys. Rev.* **93**, 882-8 (1954) Feb. 15.

The classical equations of motion of particles which are simple poles of both the electromagnetic and the neutral (scalar or vector) mesonic field are formulated both for field theory and for the theory of action at a distance. These equations are used to discuss the field contributions to the mass of the particles, the scattering of electromagnetic radiation, photomeson production, mesonic production of electromagnetic radiation, and the electromagnetic corrections for meson scattering. (auth)

3144

INGOING WAVES IN FINAL STATE OF SCATTERING PROBLEMS. G. Breit (Yale Univ., New Haven, Conn.) and H. A. Bethe (Cornell Univ., Ithaca, N. Y.). *Phys. Rev.* **93**, 888-90 (1954) Feb. 15.

The employment of the ingoing wave modification of plane waves in final states is justified by a general argument. (auth)

3145

NONCONSERVATION OF REST MASS AND THE DIRAC EQUATION. Lloyd Motz (Columbia Univ., New York) *Phys. Rev.* **93**, 901-2 (1954) Feb. 15.

Attempts have been made to introduce a fundamental length into the quantum theory of a particle without destroying the covariance of the equations. These theories are closely related to the notion that the coordinates and time describing the motion of a particle are not parameters but observables that must be represented by operators. A somewhat similar point of view is arrived at in this note by considering a system in which the rest mass  $m_0$  is not conserved. (L.M.T.)

3146

RADIATIVE CORRECTIONS IN POSITRONIUM. Thomas

Fulton and Paul C. Martin (Harvard Univ., Cambridge, Mass.). *Phys. Rev.* **93**, 903-4 (1954) Feb. 15.

All corrections of order  $\alpha^5$  to the  $n = 2$  levels of positronium are evaluated using the relativistic two-body equation with techniques recently proposed by several authors. (auth)

3147

BOUND STATE CORRECTIONS IN TWO-BODY SYSTEMS.

Thomas Fulton (Harvard Univ., Cambridge, Mass.) and Robert Karplus (Univ. of California, Berkeley). *Phys. Rev.* **93**, 1109-16 (1954) Mar. 1.

Available expressions for two-body equations contain an interaction kernel which treats particles in intermediate states as free. In situations where the binding is important, such as the calculation of low-energy electrodynamic corrections, a more accurate treatment is necessary. A satisfactory formalism is developed for systems in which an instantaneous interaction is responsible for the binding. The procedure may then be used to evaluate the effects of small retarded perturbations. It consists of summing those binding interactions which occur during the retarded perturbations and which never should have been expanded as "small" effects. The result is expressed in terms of the two-body Green's function of the instantaneously interacting system. This function occurs to describe the propagation of the two particles in the intermediate state. The relative time coordinate does not appear explicitly in the formulas. The method is applied to the calculation of the hyperfine structure of positronium. The infrared divergences which occurred in a previous investigation of this effect are eliminated by the new approach. (auth)

3148

ELECTRON-NEUTRINO ANGULAR CORRELATION FUNCTIONS IN THE THEORY OF BETA DECAY. G. N. Fowler (Univ. of Manchester, England). *Proc. Phys. Soc. (London)* **A67**, 117-24 (1954) Feb. 1.

The angular correlation functions have been calculated for linear combinations of interactions (excluding combinations of scalar and vector interactions or of tensor and axial vector interactions) in the first and second forbidden approximations with neglect of the coulomb field corrections. (auth)

3149

SINGULARITIES OF ELECTRON KERNEL FUNCTIONS IN AN EXTERNAL ELECTROMAGNETIC FIELD. J. G. Valatin (Inst. for Theoretical Physics, Copenhagen, Denmark and Institute Henri Poincaré, Paris, France). *Proc. Roy. Soc. (London)* **A222**, 93-108 (1954) Feb. 23.

The electron kernel functions are derived from solution of the second-order wave equation, using the proper-time parameterization. Iterated kernel functions are introduced and a gauge-independent perturbation theory is developed. The separation of singular parts proceeds in terms of the iterated kernel functions valid in the absence of an electromagnetic field, and the singular expressions which have to be compensated in order to determine the physically significant part of the vacuum polarization are obtained in a more transparent form than those given originally by Heisenberg. (auth)

3150

BHABHA'S EQUATION FOR A PARTICLE OF TWO MASS STATES IN RARITA-SCHWINGER FORM. K. K. Gupta (Tata Inst. of Fundamental Research, Bombay, India). *Proc. Roy. Soc. (London)* **A222**, 118-27 (1954) Feb. 23.

The irreducible relativistic wave equation for a particle having two different mass states and positive charge, given by Bhabha, has been written in a form similar to that given by Rarita and Schwinger for the Dirac-Fierz-Pauli



equation for a particle of spin  $\frac{1}{2}$ . The components of the wave function are written as Dirac four-component wave functions, having in addition a tensor index, and one ordinary Dirac four-component wave function. The only matrices which enter into the formulation are the Dirac matrices. An explicit representation of Bhabha's matrices in terms of the Dirac matrices is obtained. The solutions for spin  $\frac{1}{2}$  are just those given by the Dirac-Fierz-Pauli equation, but the solutions for spin  $\frac{1}{2}$  differ from the Dirac solutions in having additional nonvanishing components. (auth)

3151

ON A FIVE DIMENSIONAL REPRESENTATION OF THE ELECTROMAGNETIC AND ELECTRON FIELD EQUATIONS IN A CURVED SPACE-TIME. Mineo Ikeda (Hiroshima Univ., Japan). *Progr. Theoret. Phys. (Japan)* **10**, 483-98 (1953) Nov.

A five-dimensional representation of the electromagnetic and electron field equations in a curved space-time which is immersible in a flat space of five dimensions is proposed. This representation is simplified by restricting basic coördinate transformations to the transformations that connect the "equivalent" frames of reference. In the de Sitter space-time, the results are compared with the formalism proposed by Dirac some 20 years ago. The gap of Dirac's formalism is pointed out, and it is shown that the gap automatically disappears in this theory. Particularly, a new representation of the electron wave equation other than that given in Dirac's paper is obtained. The present investigation is a generalization of Dirac's formalism to a more general space-time. (auth)

3152

ON THE FUNDAMENTAL EQUATION FOR THE NUCLEON. Takao Okabayashi (Tokyo Univ., Japan). *Progr. Theoret. Phys. (Japan)* **10**, 499-504(1953) Nov.

The validity of Dirac's wave equation for the nucleon is investigated, and a modification is proposed to fit the results to meson theory. (K.S.)

3153

STATIC SPHERICALLY SYMMETRIC SPACE-TIMES IN GENERAL RELATIVITY. Hoyotirô Takeno (Hiroshima Univ., Japan). *Progr. Theoret. Phys. (Japan)* **10**, 509-17 (1953) Nov.

The term 'static' used in general relativity in connection with spherically symmetric space-times is usually used in order to qualify the forms of their line elements. The concept of the 'staticness' of a spherically symmetric space-time is introduced as an intrinsic property assuming that the mathematical aspect of general relativity is a theory of analytical invariants. Then some properties of static spherically symmetric space-times are made clear. The method used is based on the theory of characteristic systems of spherically symmetric space-times. (auth)

3154

HAMILTONIAN FORMALISM IN NON-LOCAL FIELD THEORIES. Chushiro Hayashi (Naniwa Univ., Osaka, Japan). *Progr. Theoret. Phys. (Japan)* **10**, 533-48(1953) Nov.

The Yang-Feldman method is generalized in order to obtain a covariant Hamiltonian formulation of quantized fields with nonlocal interactions. The interaction Hamiltonian is constructed according to the perturbation theory in such a way that the equation of motion in the interaction representation is integrable. The calculations are actually carried out to the fourth-order approximation. (auth)

3155

MANY-BODY PROBLEM IN QUANTUM FIELD THEORY. Kazuhiko Nishijima (Osaka City Univ., Japan). *Progr. Theoret. Phys. (Japan)* **10**, 549-74(1953) Nov.

The Feynman-Dyson theory is extended so as to include the scattering involving composite particles. The relation of the Salpeter-Bethe wave functions to the probability

amplitude is clarified by introducing co- and contravariant components of state vectors, keeping a close correspondence to the vector analysis in an oblique coördinate system. The integral equations for various kinds of Feynman kernels are derived in a systematic way by making use of functional differentiations with respect to external sources, and these equations are shown to have formal solutions expressed in terms of Fermion kernels and various interaction operators. The procedure introduced by Gell-Mann and Low is fully utilized to derive integral equations for the covariant components with devices to suitably take account of the initial conditions. The method to construct the S-matrix is discussed. (auth)

3156

SPINOR THEORY OF ELEMENTARY PARTICLES I. BASIS OF THE MODIFIED THEORY. Ferdinand Cap (Univ. of Innsbruck, Germany). *Z. Naturforsch.* **8a**, 740-4(1953) Nov. (In German) (cf. *Phys. Rev.* **93**, 907(1954) Feb. 15.)

Whereas the usual spinor theory of elementary particles worked with more than  $2(2s+1)$  spinor components and spinors were used with point and nonpoint indices, the suggested theory is content with  $2(2s+1)$  spinor components, coming from spinors which possess only an index quality and complies with differential equations of the second order. The usual theory is first discussed, and then the ground work of the new theory is presented. (tr-auth)

3157

SPINOR THEORY OF ELEMENTARY PARTICLES. II. MATHEMATICAL DERIVATION OF THE POSTULATES DESCRIBING REAL WAVE FUNCTIONS WITH  $2(2s+1)$  OR  $4(2s+1)$ . Hermann Donnert (Univ. of Cologne, Germany). *Z. Naturforsch.* **8a**, 745-7(1953) Nov. (In German)

It is shown that the Dirac wave equations for elementary particles with nonvanishing rest mass and maximum spin  $s$  are equivalent to the Schrödinger-Gordon equation for the components of two fully symmetrical spinors of the  $s$  rank with  $2s+1$  different complex components in the case of the force-free motion of particles. In the case of integral maximum spin the Dirac equations are also equivalent to the Schrödinger-Gordon equation for  $2s+1$  different complex components of a tensor. It is shown that in the case of the force-free motion of elementary particles the demands of the Cap hypothesis are fulfilled. (tr-auth)

3158

SPINOR THEORY OF ELEMENTARY PARTICLES. III. THE FREE PARTICLE. Ferdinand Cap (Univ. of Innsbruck, Germany). *Z. Naturforsch.* **8a**, 748-53(1953) Nov. (In German)

In addition to the external degrees of freedom of translation, elementary particles possess two internal degrees of freedom: electric charge and spin. Since, apart from the neutral (and "antineutral") particles, only two charge states, positive and negative, are realized and since a particle with maximum spin  $s$  possesses a known  $2s+1$  possibility of focusing the spin to a suggested direction,  $2(2s+1)$  different physical conditions can be distinguished in charged particles of maximum spin  $s$ . Since generally in physics the number of functions, which describe a reaction, is equal to the number of physically possible states, the hypothesis was set up that it must be possible by mathematical and physical means to describe a charged elementary particle with maximum spin  $s$  with  $2(2s+1)$  functions. It is shown that the description of force-free particles according to the modified spinor theory furnishes also physically correct measurements. (tr-auth)

3159

THE MOTION OF CHARGE CARRIERS IN NON-HOMOGENEOUS FIELDS. W. Bez and K.-H. Höcker (Technischen Hochschule, Stuttgart, Germany). *Z. Naturforsch.* **9a**, 64-6 (1954) Jan. (In German)



Two differential equations were derived which allowed the calculation, by suggested potential course, of the velocity of the charge carriers in field direction and the calculation of the energy remaining in the unordered motion. (tr-auth)

#### URANIUM AND URANIUM COMPOUNDS

3160

Livermore Research Lab., Calif. Research and Development Co.  
CALORIMETRIC MEASUREMENT OF THE ENERGY RELEASED IN A ONE RANGE URANIUM CYCLOTRON TARGET BY 189-MEV DEUTERONS. R. M. Horning, M. F. Katzer, R. L. McKisson, and C. C. Old. Dec. 1953. Decl. Feb. 12, 1954. 30p. Contract AT(11-1)-74. (LRL-70)

A calorimetric measurement of the energy released within a U cyclotron target by 189-Mev deuterons has been made. The average total energy released in the test targets in the three runs is 185.5 Mev per deuteron. The result of a theoretical computation, 186.3 Mev per deuteron, is in excellent agreement with the experimental value. The computed energy release for each section of the five-segment target agrees with the experimental value. (auth)

3161

ON THE STUDY OF BI-PARTITION AND TRI-PARTITION OF URANIUM NUCLEUS. S. P. Dutta (Bose Research Inst., Calcutta, India). *Indian J. Phys.* 27, 547-56(1953) Nov.

Binary and ternary fissions of U under the action of slow neutrons have been studied by photographic emulsion techniques to establish the fact that in the case of tripartition, the third fragment may not necessarily be a light particle, of the nature of an  $\alpha$  particle, but can have a mass greater than 4. Accordingly, it was necessary to desensitize the experimental nuclear plates by increasing the concentration of  $\text{UO}_2(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$  in alcohol. A concentration of 12 to 16% was found most favorable due to various factors. More than 20,000 cases of bipartition and one interesting case of tripartition were observed. The calculated mass values were 166, 43, and 30, but from the nature of ionization the mass value of the third fragment is expected to lie between 15 to 20 instead of 30. The calculated kinetic energy of this tripartition is  $2 \times 10^8$  ev instead of  $1.5 \times 10^8$  ev, and hence it is assumed that the fission has been initiated by a high-energy fast neutron (of cosmic-ray origin) the direction and value of which only can help to determine the correct mass values. In such a highly desensitized plate the total range distribution of the two fission fragments has been shown by a histogram, and most of them lie between 20 and 21  $\mu$ . The corresponding value in a nondesensitized plate is 24  $\mu$ , approximately. (auth)

3162

DISTRIBUTION OF PROMPT-NEUTRON EMISSION PROBABILITY FOR THE FISSION FRAGMENTS OF  $\text{U}^{235}$ . J. S. Fraser and J. C. D. Milton (Atomic Energy of Canada, Ltd., Chalk River, Ontario). *Phys. Rev.* 93, 818-24 (1954) Feb. 15.

The kinetic energies of both members of coincident fragment pairs were measured in a double back-to-back grid ionization chamber. The pulse heights were recorded only when coincident with a prompt fast neutron detected in either one of two neutron counters placed on opposite sides of the fission chamber. The strong angular correlation of the direction of motion of the prompt fission neutrons with the direction of motion of the emitting fragment permitted the identification of the latter as the emitting fragment. The frequency distributions of modes obtained by gating with a neutron from the light or from the heavy fragment were compared with the distribution recorded without a neutron coincidence. Comparison of

the three sets of data show (1) that neutron emission from the light fragment predominates at low mass ratios, whereas at high mass ratios neutron emission from the heavy fragment is more probable; (2) that a broad maximum in the total neutron yield exists in the region of the most probable fission mode; and (3) that the average total kinetic energy curve is essentially the same for the three conditions of measurement. (auth)

## PATENTS

#### BIOLOGY

3163

EXPOSURE CAPSULE HANDLING DEVICE. P. O. Schallert, E. R. Tompkins, and M. B. Hawkins (to U. S. Atomic Energy Commission). U. S. Patent 2,675,487, Apr. 13, 1954.

Devices and techniques to protect personnel from the destructive radiations from radioactive material are reported. In particular, a readily transportable shielded container for capsules or cartridges of radioactive material is disclosed. The container is provided with means for removing the radioactive material from the container.

#### CHEMISTRY

3164

PROCESS FOR THE PRODUCTION OF FLUORINATED DIKETONES. M. W. Davis, Jr. (to U. S. Atomic Energy Commission). U. S. Patent 2,670,353, Feb. 23, 1954.

Fluorinated  $\beta$ -diketones may be produced by means of the Claisen condensation reaction. The process consists of reacting a Na alkylate with a fluoroacetate ester in a favorable medium. When this first reaction is complete, a ketone is added to the reaction mixture, thereby initiating a second reaction which is allowed to proceed to completion to produce the precursor of the final product.

3165

REACTION AND SEPARATION VESSEL. R. C. Schultz (to U. S. Atomic Energy Commission). U. S. Patent 2,672,404, Mar. 16, 1954.

The reaction and separation vessel is used where one product of the reaction is a solid adherent material which is separated for fluid reactants. The invention provides a scraper construction which effectively scrapes away and removes adherent materials from the walls of the reaction and separation vessels and also from the scrapers.

3166

PREPARATION OF URANIUM TETRAFLUORIDE. E. C. Evers and M. B. Reynolds (to U. S. Atomic Energy Commission). U. S. Patent 2,674,518, Apr. 6, 1954.

The process for preparing  $\text{UF}_4$  comprises reacting an oxide of U with a fluorochloroparaffinic hydrocarbon, such as tetrafluorodichloroethane, at elevated temperatures, for example within the range of from about 350 to about 700°C. The product so produced is uranium tetrafluoride of a uniform green color, having a bulk density varying from about 1.9 to 3.65.

#### ENGINEERING

3167

SYLPHON SEALED PUMP. E. T. Booth and H. C. Paxton (to U. S. Atomic Energy Commission). U. S. Patent 2,668,656, Feb. 9, 1954.

Reciprocating pumps and particularly an improved type of double-acting reciprocating piston pump especially adapted for handling corrosive gases are described. The invention contemplates the employment of a piston formed of a relatively thin plate and operated with a short stroke



wherein the leakage past the piston is reduced by providing a peripheral flange extending upwardly and downwardly beyond the two faces of the piston.

3168

**DISTILLATION SYSTEM FOR RECOVERING SPENT PUMPING OILS.** R. J. Schmidt (to U. S. Atomic Energy Commission). U. S. Patent 2,668,794, Feb. 9, 1954.

An apparatus and distillation process for the manufacture and recovery of high-vacuum oils are disclosed. The device comprises an interposed group of concentric pumping members which not only function to aid in producing reduced pressure but which also furnish an index of the degree of purification of the liquid being processed or recovered.

3169

**ELECTROMAGNETIC FLUID PUMP.** N. H. Godbold (to U. S. Atomic Energy Commission). U. S. Patent 2,669,183, Feb. 16, 1954.

An improvement in electromagnetic fluid pumps and particularly an improved magnetic and fluid channel structure in which the induction motor principle is utilized in a manner which results in an enhanced fluid pressure and flow are reported.

3170

**ELECTROMAGNETIC FLUID PUMP.** N. H. Godbold (to U. S. Atomic Energy Commission). U. S. Patent 2,669,931, Feb. 23, 1954.

The electromagnetic fluid pump impels an electrically conducting fluid along a channel by the magnetic force which results from an electric current passing through the fluid in a magnetic field. The magnetic force is utilized to cause a rotary motion of a liquid mass, and the pressure head is obtained from the resulting centrifugal force.

## PHYSICS

3171

**ION SOURCE.** C. F. Barnett and C. B. Mills (to U. S. Atomic Energy Commission). U. S. Patent 2,668,260, Feb. 2, 1954.

A source of ions for a particle accelerator such as a cyclotron is described. The ion source comprises a carbon anode envelope and a pair of thermionic cathodes. The cathodes are of such material that they are readily heated, so that when they are bombarded by ions of sufficient energy and intensity they become incandescent and supply thermally emitted electrons to the plasma.

3172

**VOLTAGE REGULATOR.** E. J. Groth (to U. S. Atomic Energy Commission). U. S. Patent 2,668,272, Feb. 2, 1954.

A voltage regulator of the type wherein variations of the output voltage from a desired value are detected, amplified, and employed to control a variable resistive element in series with the source voltage is reported.

3173

**CONTINUOUS RECORDING HIGH SPEED FRAME CAMERA.** B. Brixner (to U. S. Atomic Energy Commission). U. S. Patent 2,668,473, Feb. 9, 1954.

A high-speed camera is disclosed having an optical speed such that images of sufficient size and good resolution may be reproduced at the repetition rate of millions of frames per second. The camera utilizes a rotating mirror to reproduce event images on a stationary film and attains a rapid image rotation by the operation of the mirror in combination with a dual optical system.

3174

**RELAY SYSTEM.** L. G. Nierman (to U. S. Atomic Energy Commission). U. S. Patent 2,668,934, Feb. 9, 1954.

The electronic relay system actuates an electrically operated device under desired conditions detected by any

suitable condition-responsive means. The system incorporates a plurality of mechanical relays and a plurality of electronic relays operatively associated therewith for the purpose of insuring actuation of the associated device under the proper conditions.

3175

**COUPLING STAGE FOR DISTRIBUTED AMPLIFIERS STAGES.** G. G. Kelley (to U. S. Atomic Energy Commission). U. S. Patent 2,670,408, Feb. 23, 1954.

The improved amplifier system utilizes distributed amplification wherein the desired over-all gain of the system is maintained, even at low frequencies. The system is provided with a novel coupling between the stages of the distributed amplifier whereby the voltage gain per stage is substantially doubled.

3176

**ACCELERATOR TARGET HOLDER.** C. M. Gordon and C. A. Corum (to U. S. Atomic Energy Commission). U. S. Patent 2,670,440, Feb. 23, 1954.

The apparatus accurately positions target material in the path of the beam. The target apparatus is capable of quick positioning for irradiation and is provided with a fluid cooling portion. The target and its associated cooling portion are capable of quick detachment in order that the target may be replaced.

3177

**PRESSURE REGULATOR.** W. B. Leslie and O. K. Neville (to U. S. Atomic Energy Commission). U. S. Patent 2,672,154, Mar. 16, 1954.

The liquid-medium pressure regulator for use in connection with chemical reactions and systems comprises a tubular body of angular configuration, an inlet opening for the body, a nipple carried by the body and providing an outlet opening, a liquid pressure medium normally covering an end of the nipple for closing the outlet opening, means for applying a critical pressure to medium for displacing it and uncovering the end of the nipple, and means for distorting the angular configurations of the body to alter the critical pressure.

3178

**ELECTRONIC TIMING DEVICE.** R. B. Leighton (to U. S. Atomic Energy Commission). U. S. Patent 2,672,556, Mar. 16, 1954.

The simple and reliable electronic device generates an audio tone having one selected frequency when impressed with a plurality of impulses all of which occur within a selected time interval and an audio tone of different frequency when one or more of the impulses occur after the lapse of the selected time interval.

3179

**MULTIPACTOR TUBE OSCILLATOR.** W. R. Baker (to U. S. Atomic Energy Commission). U. S. Patent 2,674,694, Apr. 6, 1954.

The tube comprises a pair of electrodes, an antenna disposed parallel to the shortest distance between the electrodes, a high-frequency oscillator energizing the antenna in the transverse electric mode, and waveguide between the antenna and electrodes whereby a potential difference from the antenna is impressed upon the electrodes, the potential having the proper magnitude and frequency to produce multipaction between the electrodes.

3180

**BEAM DEFINING APPARATUS.** J. L. Danforth and L. R. McIntosh (to U. S. Atomic Energy Commission). U. S. Patent 2,674,698, Apr. 6, 1954.

A unitary beam defining or collimating apparatus for observing, controlling, and measuring a beam of high-energy charged atomic particles in a vacuum preparatory to using the defined beam upon a target is reported.



